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*In India, grain reaped by hand is trodden from the husk by cattle and winnowed in the wind. Input of capital is low, labor requirement high.*

*Progress and Economic Problems in —*

# FARM MECHANIZATION

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*Food and Agriculture Organization of the United Nations  
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## P R E F A C E

THIS REPORT brings together, for the first time, information on progress in the manufacture and utilization of farm machinery and equipment and on world trade in these products. Together with a review of these trends, it examines some of the complex economic problems associated with raising the level of farm mechanization. These problems vary sharply from country to country and from region to region. Yet agriculture at any one of the various stages of development can benefit from study of major trends and experience under various conditions. The report is offered for the use of government officials and others interested in improving the standard of farm equipment in their respective countries and in developing programs suited to local conditions.

While the term "mechanization" embraces every form of farm equipment from the simplest to the most complex, the statistical information available makes it necessary to confine quantitative analysis to tractors and other factory-produced equipment. The wide diversity of this machinery and the lack of uniformity in national statistics further complicate any detailed comparison of particular items of equipment other than tractors. Statistical reports frequently do not distinguish between tractors used for agricultural and non-agricultural purposes, and most of them do not record the types and sizes of the machines. Under the circumstances, tractors only are expressed in units in this publication; other types of factory-produced equipment are measured in terms of market value. The latter include tillage and cultivating implements, seeding and harvesting equipment, sprayers and dusters, barnyard equipment, dairy farm requisites, and spare parts, but not irrigation pumps and stationary engines. In much of the discussion the tractor has been used as the symbol of power-operated equipment in general.

Statistics of machinery production, exports, and imports have been used more to illustrate trends and problems than to supply a detailed

record of basic data. FAO publishes up-to-date statistics on tractors and farm machinery in its regular publications, such as the *Monthly Bulletin of Food and Agricultural Statistics*<sup>1</sup> and the *Yearbook of Food and Agricultural Statistics*.<sup>2</sup>

\* \* \*

The following symbols are used throughout the statistical tables in this study:

- . . . Information unavailable;
- Nil or negligible.

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<sup>1</sup>See August 1950.

<sup>2</sup>See Vol. I, Production, 1949.

Progress and Economic Problems  
in Farm Mechanization

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ERRATUM

Map on pages 6 and 7

- Denmark.            Should be shaded to represent  
                     "150-500 hectares per tractor."
- Australia:        Shading of Tasmania should be  
                     reversed; western portion is not  
                     arable, eastern portion is arable.
- New Zealand:      Shading should be reversed; western  
                     portion is not arable, eastern por-  
                     tion is arable.



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## *World Trends in the Adoption of Factory-produced Farm Machinery*

PROGRESS in the improvement of tools and machines has not been uniform. In world agriculture at present there are many different technological levels, and often several stages of development are represented side by side in the same area. Speaking very roughly, hand tools are characteristic of Africa, simple animal-drawn implements of the ancient cultures in southern and eastern Asia, and more highly developed animal-drawn and power-operated equipment of Europe, North America, the U. S. S. R., and Oceania. Latin America has a wide variety of equipment.

Generally, progress in the efficiency of agricultural equipment has taken place in conjunction with the growth of other industries. The increased numbers and rising living standards of urban workers have resulted in increased demand for farm products, calling for greater skill and productivity from the workers that remain on farms and creating a strong economic justification for the introduction of labor-saving farm machinery to enable the remaining workers to work at greater efficiency. Countries, therefore, with a high level of agricultural technology are, with few exceptions, also those with high levels of industrial and general economic development. In the light of this experience, policies directed at improving farm equipment need to take into account all other relevant features of the economy of the area concerned.

The recognition that various levels of technological development will exist for a long time is important if a rational approach is to be made to the problem of improving the efficiency of farming all over the world. The kind of question to be decided is often whether, in the light of prevailing conditions, it is better to devote effort and expense to a gradual improvement of existing practices, or to the introduction of more radical changes. These alternatives are not, of course, mutually exclusive. For example, modern power-operated equipment judiciously used for special projects can confer great and immediate benefits even if the existing agricultural conditions of a country do not permit widespread heavy mechanization.

Certain broad trends may be distinguished in the application of improved agricultural machinery. Tractor numbers in use in the world have roughly doubled in each decade since 1930. Most tractors and other highly developed farm equipment have gone into use in the technically advanced regions of the world. A beginning has, however, been made in the underdeveloped regions in the introduction of power-driven machinery. Although these regions consumed only 7 percent of world output of factory-produced farm equipment in 1948, their potential requirements may be tremendous. The volume of farm machinery sales in the world has expanded greatly in the few years following World War II, but long-term trends are difficult to predict as they are likely to be largely dependent on trends in agricultural prices and the solution of balance-of-payments problems.

It seems clear that abundant factory capacity exists to meet all probable demands for farm machinery for some years, but there is considerable scope for the development of new designs particularly suited to tropical and subtropical agriculture, as well as for progressive refinement and specialization of existing types of machinery. Conditions are favorable for carrying out mechanization programs which were delayed during and immediately after the war by difficulties in obtaining delivery of the appropriate kinds of equipment.

### *Animal and Mechanical Power in World Agriculture*

Despite the rapid increase in the number of tractors in use in the world since the early part of the century, more than 85 percent of the total draft power used in farming operations is still provided



Table 1.—ESTIMATED DRAFT POWER IN AGRICULTURE, REGIONAL AND WORLD TOTALS<sup>1</sup>

Region <sup>2</sup>	1930			1938/39			1946/47			1948/49		
	Tractor	Draft animal	Total draft power units	Tractor	Draft animal	Total draft power units	Tractor	Draft animal	Total draft power units	Tractor	Draft animal	Total draft power units
(..... Million units .....)												
North America..	6.1	17.4	23.5	9.6	12.4	22.0	17.2	8.4	25.6	22.2	7.2	29.4
United Kingdom	0.1	0.8	0.9	0.4	0.8	1.2	1.2	0.6	1.8	1.7	0.5	2.2
Europe (excl. U. K.).....	0.7	21.3	22.0	1.2	21.2	22.4	1.9	17.1	19.0	3.0	17.9	20.9
U. S. S. R.....	0.4	24.8	25.2	3.1	12.9	16.0	2.4	9.5	11.9	3.0	11.1	14.1
Latin America..	0.1	37.6	37.7	0.2	42.1	42.3	0.4	44.9	45.3	0.4	45.2	45.6
Near East.....	...	7.8	7.8	...	8.6	8.6	0.1	8.9	9.0	0.1	9.2	9.3
Far East.....	...	89.6	89.6	...	98.1	98.1	0.1	88.6	88.7	0.1	90.0	90.1
Africa.....	0.1	13.4	13.5	0.1	12.8	12.9	0.2	16.8	17.0	0.3	17.1	17.4
Oceania.....	0.2	1.5	1.7	0.3	1.4	1.7	0.5	1.0	1.5	0.6	1.0	1.6
TOTAL.....	7.7	214.2	221.9	14.9	210.3	225.2	24.0	195.8	219.8	31.4	199.2	230.6

<sup>1</sup>In draft power units as follows: Tractor = 6; horse or mule = 1; buffalo = 0.9; draft cattle = 0.5.  
For tractor numbers, see Table 2.

<sup>2</sup>Regions are defined as follows:

North America—Canada, United States, Alaska, Hawaiian Islands.

Europe—Excludes U. S. S. R. and Turkey.

Latin America—Central and South America and the Caribbean area.

Near East—Turkey, Iraq, Iran, Afghanistan, Syria, Lebanon, Israel, Saudi Arabia and neighboring territories, Egypt, Anglo-Egyptian Sudan, Ethiopia, Eritrea.

Far East—Countries of Southeastern Asia. Excludes U. S. S. R.

Africa—Excludes Egypt, Anglo-Egyptian Sudan, Ethiopia, and Eritrea.

Oceania—Australia, New Zealand, and islands in the Southwest and Central Pacific.

U. S. S. R.—Includes European Russia.

by work animals. Some tentative estimates of draft power units employed in agriculture in the several regions are shown in Table 1.

The most striking facts revealed by this table are the great preponderance of animal over mechanical power in agriculture in all regions of the world except North America and the progressive increase in available power over the period reviewed except for a sharp but probably temporary drop in Europe, the U. S. S. R., and the Far East as a result of the combined effects of war devastation and livestock diseases. Gradual restoration of work-animal numbers is taking place in the devastated areas, and progress continues to be made against rinderpest and other animal diseases in Asia, Africa, and other regions.

In many areas animal-operated implements are of traditional design and are often made locally; but where agriculture has been influenced by industrial countries, such equipment is usually of recent design and is factory-produced, frequently by the same process as similar tractor-operated implements. The significance of



*Leveling rice land with hand tools in China.*

factory-produced machinery in world agriculture is, therefore, greater than the ratio of tractor to animal power might suggest. But it is still comparatively small, and extended use of more efficient equipment is one of the principal ways by which productivity and hence living standards of farm labor can be raised. This does not necessarily mean the adoption in underdeveloped regions of machinery designed mainly for conditions in Western Europe and North America.

## Tractor Numbers

Tractors and associated equipment continue to be used on an ever-increasing scale in the more developed regions and are finding increasing application, often for special purposes such as land reclamation, in areas previously little affected by mechanization of this type. Table 2 illustrates the rapid but uneven adoption of tractors in the major regions of the world since 1930.<sup>1</sup> Striking features of

<sup>1</sup>The 1948/49 tractor inventory statistics for individual countries are given in Part II.

Table 2.—TRENDS IN TRACTOR NUMBERS, 1930-1948/49

Region	Estimated tractor inventories <sup>1</sup>				Percentage of:	
	1930	1938/39	1946/47	1948/49	World tractors 1948/49	World arable land <sup>2</sup>
	( . . . . Thousand units . . . . )				( . . Percent . . )	
North America.....	1,020	1,597	2,890	3,700	70.8	17.2
United Kingdom.....	20	60	200	285	} 15.0	12.2
Europe (excl. U. K.).....	110	205	312	501		
U. S. S. R.....	72	523	400	500	9.6	18.4
Latin America.....	20	35	62	70	1.3	9.3
Near East.....	2	5	10	13	0.2	6.1
Far East.....	1	3	10	13	0.2	22.9
Africa.....	10	17	30	52	1.0	12.4
Oceania.....	32	53	90	101	1.9	1.5
TOTAL.....	1,287	2,498	4,004	5,235	100.0	100.0

<sup>1</sup>As far as possible, the figures given here refer to agricultural tractors, but in some cases no clear separation from horticultural types and tractors used for nonagricultural purposes can be made.

<sup>2</sup>Includes temporary fallow, temporary meadows and pastures, garden land, orchards and fruit-bearing shrubs.

Areas where there is little or no cultivation have not been shaded. National average figures have been used, with no attempt to distinguish variations in the density of tractor distribution within country boundaries.



# WORLD DISTRIBUTION OF TRACTORS IN RELATION TO ARABLE LAND





this development are the fourfold increase in world tractor numbers in the 19-year period; the concentration of tractors in North America, Europe, the U. S. S. R., and Oceania (97.5 percent of the world's total) and the small proportion in Latin America, the Far East, the Near East, and Africa (only 2.5 percent of the world's tractors on nearly half the world's cultivated land); and the recent intensification of power farming in Europe. Tractors are being more generally introduced in all regions, even where fuel import problems exist, not only to obtain the labor saving and other benefits derived from greater speed of operation, but also to release for human consumption the production of approximately one hectare of land for each animal displaced. A diminishing proportion of the modern farm machinery being manufactured is designed for operation by draft animals; to an increasing extent in the future, therefore, tractor numbers are likely to provide an index of the level of mechanization.

The map on pages 6 and 7 illustrates the geographical distribution and density of tractors in 1949. It is based on recently available estimates of tractor numbers and cultivated area in the various countries of the world. Countries have been classified into four categories according to the average area of crop land to each tractor in use, as follows: (i) less than 150 hectares per tractor; (ii) 150 to 500 hectares; (iii) 500 to 1,500 hectares; and (iv) over 1,500 hectares. Shaded areas correspond roughly to the distribution of agricultural land. Nonagricultural land has been left unshaded. It is apparent that all areas with a high tractor density are in the northern and southern temperate zones, usually in industrialized countries with high standards of living and high labor costs; whereas almost all areas with a very low level of modern mechanization are in or near the tropics, where in general farm labor is abundant and wages are low. Among the latter areas are some of the most densely populated parts of the world. In most of these, intensive farming methods are used, but they are based on hand and animal labor with simple, locally made implements of traditional design; productivity of labor and standards of living are generally extremely low.

It should be borne in mind when considering Tables 1 and 2, as well as the map, that tractor numbers alone do not provide a true indication of the extent to which mechanical power is actually

used on farms. The hours and type of work performed by the tractors on a year-round basis are other factors which must be considered. There is evidence from the few studies that have been made that the rate of utilization varies greatly from country to country and also changes over the years. The available information indicates a very high rate in the U. S. S. R., where a range from 800 to 1,600 hours was reported for tractors on collective farms in 1936 and an 1,100-hour average for tractors on Machine Tractor Stations in 1940. High rates of about 1,000 hours have also been reported from Mexico and Argentina.<sup>2</sup> In the highly mechanized countries of Western Europe and North America, utilization of individual units appears to be less intensive; for example, in 1949 roughly 600 hours of use was estimated for tractors in Switzerland and 800 for tractors in the United Kingdom,<sup>3</sup> whereas a survey made in the United States in 1947 gave a figure of 592 hours, which compares with 497 hours in a similar survey for 1941.<sup>4</sup> These data are not strictly comparable because details are not available on the number of hours devoted to heavy and light tillage, belt work, road hauling, etc., but they give a rough guide to the range of utilization for agricultural tractors in a few countries. The figures are national averages for all farm tractors in use. On individual farms and projects, particular machines may be worked much longer hours.

Another factor to be considered in assessing the use of power in agriculture is the average power of tractors employed. Generally countries with a more extensive agriculture, such as Argentina, the United States, and the U. S. S. R., use larger units than such countries as Belgium and the United Kingdom. Stationary oil, electric, and steam engines, windmills, and water wheels also contribute to farm power, but no comparable data on them have been assembled.

### *Production of Modern Farm Machinery and International Trade in these Items*

Manufacture of tractors is confined to a few industrialized countries. Although production of tractor-operated implements and

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<sup>2</sup>Report of ECLA-FAO Joint Working Party on Agricultural Requisites, 1949.

<sup>3</sup>Unofficial reports to FAO.

<sup>4</sup>A. P. Brodell and A. R. Kendall, *Fuel and Motor Oil Consumption and Annual Use of Farm Tractors*, U. S. Department of Agriculture, 1949, BAE Publication FM-72.

other types of modern farm equipment usually requires less advanced engineering facilities, it is also undertaken in comparatively few countries. The main centers of the industry are in North America, Western Europe, and the U. S. S. R., but there are many relatively minor establishments in other regions—for instance, in Oceania and Japan. Very few countries are completely self-sufficient in all types of equipment; to varying degrees, most depend on imported supplies from the United States, Canada, and Western Europe. The broad pattern of the industry as laid down over a considerable period of years has not changed fundamentally despite the upheaval caused by World War II. The principal change has been a decline in the importance of Germany and the emergence of the United Kingdom as the second largest producer and exporter of farm equipment, exceeded only by the United States.

For over two years after the end of the war, production of many items lagged seriously behind requirements despite strenuous efforts on the part of the industry. The greatly increased demand has been met by a very big expansion in plant capacity; this has occurred principally in the United States, the United Kingdom, and Canada, but there has also been considerable recent expansion in France, Italy, Czechoslovakia, Sweden and Switzerland. Some recovery is shown in Germany, and marked progress has been made in Austria, Poland, and Hungary. In the U. S. S. R., restoration and development of plant have proceeded rapidly. Australia has commenced the manufacture of tractors on a significant scale in addition to its long-established production of other types of farm equipment, and a foundation has been laid for some phases of the industry in Brazil, India, and a number of other countries. As a result of this growth, the volume of both world production and trade in farm equipment in 1948 was nearly three times that in 1937. In terms of value, owing to a substantial rise in prices, the increase is even more impressive.

Details of 1948 production, exports, and imports of all modern agricultural machinery, grouped in terms of value, are given on a regional basis in Table 3.

These figures, and those on tractor numbers in Table 4, illustrate very clearly the great concentration of production and trade in the industrialized countries and reveal the tremendous factory capacity that now exists for meeting any demands that may arise for machinery of this type. A significant fact emerging from con-



Table 3.—FARM MACHINERY: WORLD FACTORY PRODUCTION AND  
INTERNATIONAL TRADE, 1948  
(TOTAL VALUE, INCLUDING AND EXCLUDING TRACTORS)

Country or region	Production <sup>1</sup>		Exports <sup>2</sup>		Imports <sup>3</sup>	
	Total, including tractors	Machinery other than tractors	Total, including tractors	Machinery other than tractors	Total, including tractors	Machinery other than tractors
	( . . . . . Million U. S. dollars . . . . . )					
United States.....	1,962	983	382	189	73	51
Canada.....	148	125	84	73	132	74
United Kingdom.....	272	126	4106	28	25	19
Europe (excl. U. K.)..	5612	5430	539	427	126	72
U. S. S. R.....	5400	5265	—	—	—	—
Latin America.....	53	53	—	—	113	54
Near East.....	—	—	—	—	17	8
Far East.....	58	58	—	—	15	8
Africa.....	51	51	—	—	80	23
Oceania.....	530	526	63	63	33	11
TOTAL.....	3,436	1,967	614	320	614	320

<sup>1</sup>Factory prices.

<sup>2</sup>Gross exports priced at ports, i. e., about 20 percent above factory prices.

<sup>3</sup>Export prices at ports in United States, Canada, and the United Kingdom; also includes France, Sweden, Switzerland, and Australia where data are available.

<sup>4</sup>Excludes dairy equipment.

<sup>5</sup>Estimates made by FAO.

<sup>6</sup>1946-47 data.

sideration of these figures is that, of an estimated world output of farm machinery in 1948 valued at over \$3,000 million, over half was sold in North America and only 7 percent in the four less developed areas combined. The actual percentages of world production (in terms of value) taken by various regions in 1948 were as follows:

Region	Percentage
North America .....	53.6
Europe .....	26.0
U. S. S. R. ....	11.7
Latin America .....	3.4
Near East .....	0.5
Far East .....	0.7
Africa .....	2.4
Oceania .....	1.7

By the end of 1948 and the early part of 1949, the backlog of orders accumulated during the war had been largely satisfied. There were still shortages of a few items such as crawler and heavy wheel tractors in 1949 despite expanded production in the United States

Table 4.—WORLD TRACTOR PRODUCTION AND TRADE,  
1948 AND 1949<sup>1</sup>

Country or region	Production		Exports		Imports	
	1948	1949	1948	1949	1948	1949
	( . . . . . <i>Thousand units</i> . . . . . )					
United States:						
Wheel . . . . .	529	558	104	101	21	11
Track . . . . .	39	45	13	16	—	—
Wheel and track . . . . .	568	603	117	117	21	11
Garden . . . . .	(183)	(123)	(11)	(7)	—	—
Canada . . . . .	15	15	9	8	46	60
United Kingdom:						
Wheel and track . . . . .	117	90	69	56	2	2
Garden . . . . .	(34)	(25)	—	—	—	—
Europe (excl. U. K.) . . . . .	50	68	4	8	54	38
U. S. S. R. . . . .	67	90	—	—	—	—
Latin America . . . . .	—	—	—	—	29	19
Near East . . . . .	—	—	—	—	4	7
Far East . . . . .	—	—	—	—	3	5
Africa . . . . .	—	—	—	—	22	18
Oceania . . . . .	22	34	—	—	18	29
TOTAL (excl. garden tractors) . . . . .	819	870	199	189	199	189
TOTAL (incl. garden tractors) <sup>4</sup> . . . . .	1,036	1,018	210	196	210	196

<sup>1</sup>Figures are in some cases estimates. Trade statistics are for gross exports and imports.

<sup>2</sup>1948/49 Program.

<sup>3</sup>1949/50 Program.

<sup>4</sup>Reliable statistics on garden tractors are available only for the United States and the United Kingdom.

and greater attention by a few European manufacturers to this field. Certain types of heavy plows and some of the more specialized and complex machines, such as corn pickers for maize harvesting, were also in short supply. Construction of both mounted and trailing implements for tractors, however, was in equilibrium with tractor production, and output of combine harvesters was sufficient to meet the rapidly growing demand for these items. Well over 100,000 combines were manufactured in the United States alone in 1949. Considerable numbers were also produced in Canada, the U. S. S. R., and the United Kingdom. In the case of some items, there was evidence that the market was already oversupplied in 1949. This applied mainly to certain medium and light tractors and was reported by manufacturers in both North America and Western Europe.

Roughly a quarter of the crawler and wheel tractors produced in the world in 1948 and 1949 were exported (Table 4). The proportion of farm machinery other than tractors entering international trade was, however, somewhat less (Table 3) because manufacture of these items is often less complicated. As to the distribution of exports, the four less developed regions combined took only a third of the tractors and other farm equipment entering world trade. This proportion has not changed greatly over the last decade, as shown by Table 5, notwithstanding heavy imports in recent years for the quite highly mechanized agriculture of French North Africa and the Union of South Africa, which are included in otherwise underdeveloped regions along with such Latin-American countries as Argentina, Venezuela, and Mexico, where adoption of power farming methods is making considerable progress. The large proportion of United States and Canadian exports exchanged between these two countries is shown by the North America figures in Table 5. Oceania exports such items as seeding and harvesting equipment, but is dependent on overseas sources for most of its tractors.

In view of the great importance which questions of international exchange and balance of payments have assumed in the postwar

Table 5.—FARM MACHINERY EXPORTS (INCLUDING TRACTORS):  
PERCENTAGE OF WORLD AGGREGATE VALUE  
ENTERING VARIOUS MARKETS

Region	1937	1946	1947	1948
	( . . . . . Percent . . . . . )			
North America.....	22	33	31	34
Europe.....	27	32	26	24
U. S. S. R.....	—	1	1	—
Latin America.....	22	17	22	19
Near East.....	2	2	2	3
Far East.....	2	2	3	2
Africa.....	11	9	10	13
Oceania.....	14	4	5	5
WORLD.....	100	100	100	100
Value in million U. S. dollars.....	117	231	428	614
Number of tractors (1,000 units).....	51	78	123	199

period, it is of interest to examine briefly the relative and actual values of farm machinery imported in 1948 from hard and soft currency areas by the various regions of the world (Table 6). Some 1937 data are included for comparison. In both years roughly three-quarters of supplies entering world trade came from the dollar area. Despite restriction of dollar imports in many countries, this proportion increased somewhat in the postwar period, while the actual value involved was nearly sixfold that in the prewar year. Even more striking is the proportionate increase in imports from the sterling area, including the United Kingdom and Australia. It may be noted that the price of United States and Canadian farm equipment exports increased in this period by about 60 percent and United Kingdom exports by about 110 percent in terms of dollar values, both priced at ports in the countries of origin. The de-

Table 6.—PERCENTAGE OF FARM MACHINERY IMPORTS (INCLUDING TRACTORS) DERIVED FROM THE MAIN CURRENCY AREAS, 1948, BY REGIONS

Importing region	Dollar sources <sup>1</sup>	Sterling sources <sup>2</sup>	Other sources
	( . . . . . Percent . . . . . )		
North America.....	93	7	—
Europe.....	57	31	12
U. S. S. R.....	—	—	—
Latin America.....	90	8	2
Near East.....	80	20	. . .
Far East.....	78	22	. . .
Africa.....	75	21	4
Oceania.....	47	53	—
Percentage of total world trade, 1948.....	76	17	7
Percentage of total world trade, 1937.....	73	8	19
Value of total world trade:	( . . . . . Million U. S. dollars . . . . . )		
1948.....	466	106	42
1937.....	85	9	23

NOTE: All quantities are valued in the country of origin.

<sup>1</sup>United States and Canada.

<sup>2</sup>United Kingdom, Australia.



*A simple wooden-framed plow is used in Japan's intensive rice production. Labor input is very high.*

valuation of sterling and a number of other European currencies in September 1949 gave some competitive advantage in terms of price for tractors and other farm machinery from this area. The big percentage decline since 1937 in the "other sources" group is due mainly to the virtual disappearance of Germany as an exporter. As production increases in other European countries, exports from some of these are likely to increase; but North America and the United Kingdom will probably continue to play a dominant role.

In most countries where controls over foreign exchange have been introduced, imports of farm machinery have been granted a high priority, but this has implied careful scrutiny of agricultural requirements and some curtailment of the quantities imported, as well as diversion of orders from hard currency to soft currency ex-



porters. Important markets where restrictions have operated against imports of farm machinery from dollar sources include the major sterling area importers—Australia, the Union of South Africa, New Zealand, and India—and many countries in Latin America and other regions. Restriction of imports from the sterling area has also operated, sometimes for limited periods only, as in Mexico, France, and Argentina.

The total value of tractors and other farm machinery entering world trade in 1948 was \$614 million (Table 3); as this represents only 7 percent of the value of exports of all machinery and metal products from Canada, the United Kingdom, and the United States in that year, and less than 3 percent of the total value of exports from these countries, agricultural equipment does not account for a very large share of international payments. For this reason no special balance-of-payments problems would be likely to arise if the governments of importing countries where the importance of these items to national development warrants such action were to remove all restrictions on the import of farm machinery. Apart from the granting of a high priority for foreign exchange, importing countries may negotiate loans with such financial agencies as the International Bank for Reconstruction and Development and the United States Export-Import Bank. The European Recovery Program has also, of course, given important financial assistance to the participating countries and their dependent territories in furthering more efficient farm production through improved equipment.

### *Some Economic Problems Associated with the Introduction and Utilization of Farm Machinery*

Reference has already been made to the broad relationship that exists between the level of farm mechanization in a country and the level of general economic development as shown by the degree of industrialization. There are several other important elements which operate in the economy of most countries and regions in influencing the general technical level of agriculture and hence the nature of equipment that is appropriate. On the other hand, there is another group of economic factors connected with more specific aspects of the utilization of farm equipment and with problems of transition from one standard of farm equipment to more advanced

standards. Frequently such factors may be significant in one or more areas or regions, but not have universal importance. A case in point is tractor fuel supply, which handicaps the more rapid adoption of power-operated equipment in most countries of Europe and the Far East, for example, but is not a serious problem in the United States, the U. S. S. R., and some countries in other regions. Caution is therefore necessary in generalizing too widely in this field. Some important factors of fairly universal importance are considered briefly below. These are in some cases further illustrated in Part II in their regional setting. Other factors of more local significance are introduced in the discussion of the regions where they have special importance.

*Subdivision of agricultural land.* It is significant that mechanization of farms has usually made most headway in relatively newly developed countries where size of farms and area per agricultural worker are high, or in older agricultural systems where there has not been undue fragmentation of land holdings or where special steps have been taken to consolidate holdings or to combine them into larger co-operative or collective units. Table 7 shows for a few

Table 7.—TRACTOR DENSITY AND SIZE OF HOLDINGS,  
SELECTED COUNTRIES

Country	Percentage of agricultural land in holdings exceeding 20 hectares <sup>1</sup>	Arable land per tractor in 1949 <sup>2</sup>
	<i>Percent</i>	<i>Hectares</i>
New Zealand.....	99	Less than 150
United States.....	95	
United Kingdom.....	85	
Germany.....	66	
France.....	57	150-500
Italy.....	54	
Egypt.....	51	
Hungary.....	44	
Bulgaria.....	9	500-1,500
Philippines.....	14	Over 1,500
Japan.....	<sup>3</sup> 15	

<sup>1</sup>Mostly prewar data from IIA Yearbook, 1939-40.

<sup>2</sup>The same categories have been used as in the map on pages 6-7.

<sup>3</sup>Rough estimate.

countries the percentage of agricultural land in holdings exceeding 20 hectares and the average area of arable land to each farm tractor. Generally speaking, a higher tractor density accompanies a larger proportion of land in bigger holdings.

Not only is the over-all size of holdings important, but also their degree of fragmentation and the way in which they are subdivided. The subdivision of large holdings into small, awkwardly shaped fields with narrow lanes and entrances may obstruct the spread of more effective mechanization almost as much as small holdings themselves.

*Agricultural labor supply and wage rates.* An important factor linking the standard of farm mechanization to that of general economic development is farm labor supply and the closely related question of farm wages. Historically, advances in farm mechanization have been made where a strong demand for labor in other industries has withdrawn workers from the land and forced wage rates up. Where this demand has not arisen, a high proportion of the population is generally composed of subsistence farmers or of landless farm workers, standards of skill and wages of farm labor remain low, and there is no economic incentive for introducing labor-saving machinery. This state of affairs is characteristic of most of the underdeveloped areas of the world. Such uncertain elements as payment of farm workers in kind as well as in cash wages and the variable nature of part-time and family employment make valid international comparisons of farm wages extremely difficult, but statistics collected by the International Labour Organisation indicate that farm workers in some of the more highly mechanized countries may be paid twenty times as much as in areas where hand methods predominate. When the average value of output of the two sets of workers is compared, the disparity is equally striking. Between these extremes a rough parallelism can be traced between farm wages, productivity of labor, and the extent to which tractors are used in agriculture in various countries at different levels of development. The importance of weighing carefully such questions as labor costs and costs of machinery purchase and operation under local conditions, before embarking on radical changes in production methods and equipment, is further indicated by these considerations.

*Displacement of draft animals.* One obvious and important benefit from the use of tractors and motor transport is the liberation for



productive purposes of land otherwise required to produce feed for draft animals. Accurate estimates of the actual areas liberated in this way are few, but it appears that in the United States and Western Europe approximately 1.2 hectares (3 acres) are needed to support a horse. This area naturally varies according to the productive capacity of land used for supporting workstock, the type of draft animal employed, and the method of feeding. Another relevant question in this connection is the number of work animals actually displaced by the introduction of the tractor. This is often very much less than might at first be supposed. In attempting to estimate draft power on farms, it is customary to allow 8, 6, or 5 units for the average farm tractor in terms of horse draft-power units; 6 has been used in this report. It is usually found, also, that farmers do not immediately dispose of all their work animals even when they have tractors and associated equipment capable of doing all their work requiring draft power. Some animals may be kept as a stand-by in case of failure of the tractor, for miscellaneous light duties such as harrowing, which are sometimes performed less economically by tractor power, or, where motor trucks are not in general use, for transport purposes. The magnitude of the contribution to the agricultural resources of a country that may result from the substitution of tractors for animals is illustrated by the fact that, between 1915 and 1945, approximately four horses and mules on the average were displaced from United States farms by the addition of each tractor. The elimination of 13 million workstock involved in this change meant the release of about 15 million hectares of land for other uses. Substantial benefits have also been derived in Europe and other areas with limited land resources in relation to population. Where, on the other hand, land is plentiful and relatively cheap, there may be less incentive to adopt mechanical power requiring fuel which cannot be produced on the farm and involving repair and replacement costs. Thus in Australia and Argentina the horse is still widely used for draft power, though large modern machinery is in general use for soil-working, seeding, and harvesting.

*Cost and maintenance of machinery.* Undoubtedly one of the most important and universal factors influencing the adoption of more highly developed farm equipment is its high initial cost. Reference is made in Part II to the various measures being taken in some individual countries to assist farmers in overcoming this obstacle.

The high capital outlay involved in complex farm machines

makes it imperative for economic operation that the equipment should give long, reliable service without the need for expensive repairs and maintenance. It is clearly impossible to lay down any absolute scale of useful life to be expected from a particular piece of equipment as this will vary widely with the amount of use and kind of care it receives, but a few cases will illustrate the importance of this factor. A medium wheel tractor in the United Kingdom has been estimated to have an average life of 7.6 years.<sup>5</sup> This compares with about 12 years in the United States for machines of roughly similar quality. When, however, one takes into account the hours of use in a year, it appears that in both countries the useful operating life of a tractor is of the order of 6,000 to 7,000 hours. The over-all life of a tractor plow has been estimated at 12 years in both countries. The rough and heavy work required of farm machinery increases the need for an efficient organization to ensure not only that the operator is familiar with the proper use of the machine, but also that adjustments and repairs can be made promptly and efficiently as defects develop. The question of prompt repairs is of special importance because the speed and timeliness of operations made possible by farm machines is one of their main advantages over older methods. Long delays at critical periods may destroy any economic advantage which mechanization might otherwise confer.

An important trend in design which should contribute greatly to the ease of using and repairing farm machines, and hence to reduced operating costs, is that toward greater standardization of parts and fittings. For many reasons a completely uniform range of equipment for all crops and conditions is clearly impossible, but there are some directions in which progress can be made. This has already gone a considerable way in that such parts as ball and roller bearings are produced in a limited number of standard sizes by a few manufacturers and are used by a large number of makers of various types of machinery. In some cases several tractor manufacturers use engines, transmissions, magnetos, and other vital components produced by a single specialized maker of these components; the same is true of such items as harrow disks. Another important recent step has been the agreement to standardize American and British screw threads. Simplification and rationalization of details are being actively encouraged in Europe through the

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<sup>5</sup>Survey conducted by the National Farmer's Union of Great Britain.

International Commission for Agricultural Engineering (CIGR) with headquarters in Paris. When one considers that, according to a recent FAO survey, there are over 200 manufacturers of tractors in the world, many of them producing a range of types and often with very limited output, the advantage of having as many parts as possible interchangeable with other makes is obvious, provided that this does not involve the loss of any valuable special features the machine may have. The marked trend toward mounted tractor implements as opposed to the trailing type has led to the introduction of a variety of linkages and hydraulic control systems. Some are interchangeable, but in general the implement has to be specially made or adapted for a particular make of tractor. Attempts at standardization of these connections have met with resistance on the grounds that, as finality in design has not yet been reached, standardization would tend to hamper engineering progress. This is largely true of many of the varied constructional features of farm machinery which are still in a state of rapid evolution.

The trend toward the production of a less complex range of machinery and greater interchangeability of parts is important in the highly specialized agriculture of a region like Europe, but may be even more beneficial in areas where complex machinery is a comparative novelty and where repair facilities are relatively undeveloped. Another way of securing comparable benefits is to introduce only a limited range of makes and types into an area.

*Training of personnel.* Closely related to the question of maintenance is the availability of experienced operators and mechanics. Where sufficient persons are available who are competent in a closely allied field, rapid and easy conversion to the particular methods and skills needed for operating and maintaining farm equipment may be anticipated, as has been the case in North America, most Western European countries, and Oceania during the recent expansion of power farming practices. When, however, mechanical methods are introduced into a community which has had little previous mechanical experience, considerable difficulty is likely to arise in securing competent operation, adjustment, and repair of complex machinery. Many cases have arisen in recent years where machinery of proved worth in the country of its origin has given quite unsatisfactory service in the hands of farmers or their employees in an area unfamiliar with machinery at all, or accustomed to handling equipment of a

different type. Reports have come from Eastern Europe, the Near East, Latin America, and Africa of low serviceability, which is in many cases not connected with faulty design of the equipment in question or unsuitability for the work for which it was used. Where mechanization is being developed under government direction, or where the need for training is not being adequately met through normal commercial channels, action is required by the governments concerned. In many instances, as would be expected, this has proved to be the case in relatively unmechanized areas, where a variety of officially sponsored training programs are in effect. Some of these are described in connection with the regional surveys in Part II.

*Trends toward further specialization of machinery.* A recent trend in the design of farm machinery that has an important bearing on its economic utilization is the increase in output and the marked advances in efficiency of horticultural and small agricultural tractors. Associated with a line of equipment to perform a wide range of tasks, frequently on vegetables and other crops grown on small holdings, these are having important effects in extending the benefits of mechanical methods to the small farmer. A somewhat similar trend is taking place in the design of larger agricultural implements, which are becoming increasingly specialized for work on particular crops. To some extent, also, genetical science is being enlisted to produce strains of maize and other crops which lend themselves particularly to the rather nonselective character of operations performed mechanically, in contrast to the high degree of selection which manual labor can exert; the crop, in short, is being fitted to the machine. The combine-harvester has been adapted to a variety of grain and other field crops, such as soybeans, and machines are available for eliminating practically all hand labor from hay-making and the preparation and storage of silage. Tractor working speeds, too, have been rising with the greater use of rubber tires, high compression engines, and multispeed transmissions, requiring the development of modified working parts for plows and other tillage and cultivating implements and higher-capacity harvesting equipment.

Declining interest in the production of animal-drawn equipment in North America and Europe for local use and the rapid evolution of power-operated machines are in a sense complicating the mechanization problem in some importing areas. Countries which former-



*The single-furrow horse-drawn plow has its place on small holdings in a technically advanced country (Sweden).*



ly imported types of machines no longer being produced may have to change certain of their practices or seek alternative sources of supply. Rice binders, for example, which have been superseded in most rice areas of the United States, are no longer manufactured by some of the main exporting companies, although binders have advantages over the more expensive combines in some rice-producing areas in Latin America and the Far East. The same applies to certain other items of equipment that are considered obsolescent in highly mechanized countries but are still widely used in areas where methods are less specialized and labor is cheaper and more plentiful. An effect of this may be to stimulate the production, either locally or in other industrialized countries, of equipment more closely adapted to local conditions, both physical and economic.

# *Regional Aspects of Farm Mechanization*

## *North America*

NO ATTEMPT is being made here to deal in detail with the immensely complex body of information that has accumulated on farm machinery and its utilization in North America. It is proposed rather to summarize the salient facts regarding changes during recent years in production and exports, and to outline some general experiences within the region which may be of interest to other areas engaged in the extension of farm mechanization.

North America is usually regarded as the outstanding example of progress in modern farm mechanization. With some 17 percent of the world's arable land, the region has over 70 percent of the world's tractors. In addition to equipment for land preparation, seeding, etc., large numbers of complex machines are used for such agricultural operations as harvesting of wheat and maize, haymaking and baling, and the preparation and handling of livestock feed-stuffs. This widespread use of power-operated machinery in North American agriculture has been attributed largely to the following conditions:

- (1) In both Canada and the United States very large areas of agricultural land have been opened up within the last century, when prototypes of modern farm machinery were

already in existence. Holdings were often planned for use of large horse-drawn machinery. Soils and terrain lend themselves to the use of big equipment.

- (2) The general technological level of both countries is high, and a vigorous local farm machinery industry was established at quite an early date. Active advertising, demonstration, and education have emphasized the advantages of using machinery on farms.
- (3) The growing domestic and foreign demand for food and raw materials has ensured in general a good market and profitable prices for as much produce as could be grown, although there have been temporary surpluses. A satisfactory return on capital invested in farm machinery has usually been obtained.
- (4) A relative shortage of labor and high wage rates have focused attention on the development and use of labor-saving equipment.
- (5) In more recent years the use of tractors and other sources of power has been favored by ample supplies of low-priced petroleum products and by progress in rural electrification.

These factors have not operated to the same extent, however, in all areas of North America, and the standard of farm technology is not uniformly high throughout the region. There is a marked concentration of tractors and other power-operated equipment in the central prairie areas, devoted mainly to grain farming. In the southeastern area of the United States and in parts of eastern Canada the level of farm mechanization is below the regional average.

### ***Production, Exports, and Imports***

Apart from being the greatest user of modern farm machinery, North America is also by far the greatest producer. The combined output of United States and Canadian factories in 1948, for example, accounted for two-thirds of estimated world production (Table 3) and three-quarters of supplies entering world trade. The industry of the two countries is largely complementary. In Canada, for example, tractor production is limited mainly to smaller types and does not supply domestic needs for larger types, which are imported from the United States. On the other hand, small trac-



tors, combines, and some animal-drawn implements are exported from Canada to the United States. The magnitude of this trade within the region is shown by the fact that in 1948 over 40 percent of the total farm machinery exports of Canada and the United States were exchanged between these two countries.

Table 8 summarizes recent trends in production and international trade in farm machinery in the United States and Canada. An index of prices paid by domestic consumers is included to give an indication of the extent to which the changes in the recorded value of production are due to price fluctuations. It is clear that, correcting

Table 8.—UNITED STATES AND CANADA: VALUE OF PRODUCTION, IMPORTS, AND EXPORTS OF FARM MACHINERY, INCLUDING TRACTORS

Year	Production <sup>1</sup>	Imports <sup>2</sup>	Exports <sup>2</sup>	Price index <sup>3</sup>
	( . . . . Million U. S. dollars . . . . )			(1935-39=100)
United States:				
1938.....	404	4	75	103
1939.....	386	3	66	101
1940.....	462	4	77	100
1941.....	639	7	88	101
1942.....	622	3	70	107
1943.....	602	3	103	111
1944.....	1,026	7	167	114
1945.....	997	10	163	115
1946.....	984	17	158	119
1947.....	1,503	35	315	135
1948.....	1,962	81	380	157
1949.....	2,052	83	418	176
Canada:				
1940.....	18.3	30.7	9.6	104
1945.....	57.6	50.4	20.3	...
1946.....	63.2	62.9	28.7	113
1947.....	89.4	105.6	41.5	123
1948.....	147.6	131.4	84.1	147
1949.....	...	<sup>5</sup> 170.0	<sup>5</sup> 90.0	...

<sup>1</sup>Manufacturers' sales priced at factories; includes tractors for non-farm use and excludes "miscellaneous farm equipment" such as hand tools. SOURCE: U. S. Department of Commerce, Bureau of the Census, Industry Division, *Farm Machines and Equipment 1948*, 24 June 1948.

<sup>2</sup>Priced at ports.

<sup>3</sup>In the case of the United States, prices paid by farmers for farm machinery, excluding tractors. SOURCE: U. S. Department of Agriculture, Bureau of Agricultural Economics, Crop Reporting Board, *Revised Index of Prices Paid by Farmers, including Interest, Taxes, and Wage Rates, and Revised Index of Prices Received by Farmers*, January 1950. In the case of Canada, prices paid by farmers for farm machinery.

<sup>4</sup>Price control on farm equipment was removed on 15 September 1947.

<sup>5</sup>Estimated.

for price changes, the volume of production in 1948 is more than double that of 1940 in the region as a whole. In Canada the increase is even more striking. There has also been a remarkable growth in exports, particularly in the postwar years.

Further details on United States tractor production and exports are given in Table 9. The output of wheel tractors over the period reviewed exhibits a sharp rise, and it is clear that the supplies available for export have increased greatly since the war. The increase in crawler tractor production has been slower, and exports in 1948 showed a relatively modest advance over those in prewar years. As the United States is by far the largest producer of crawler tractors, this has meant that the backlog of world demand for crawler tractors has been satisfied more slowly than demand for wheel types. This is particularly true of very heavy units for earth-moving and constructional purposes often not directly related to agriculture.

The statistics on garden tractors illustrate one of the outstanding recent developments in the application of power-farming practices in the agriculture of North America. Although most of these machines

Table 9.—UNITED STATES: TRACTOR PRODUCTION AND EXPORTS, 1938-49

Year	Tractor production				Tractor exports			
	Wheel	Crawler	Total	Garden	Wheel	Crawler	Total	Garden
	( . . . . . <i>Thousand units</i> . . . . . )							
1938....	172	17	189	10	130.5	8.9	39.4	. . .
1939....	186	20	206	10	129.7	7.8	37.5	. . .
1940....	249	25	274	9	33.5	9.2	42.7	0.8
1941....	313	29	342	16	32.9	12.1	45.3	0.7
1942....	172	30	202	13	17.3	9.7	27.3	0.8
1943....	105	29	134	9	19.5	<sup>3</sup> 9.1	28.9	3.9
1944....	249	45	294	17	41.0	<sup>3</sup> 11.8	53.6	3.5
1945....	244	45	289	28	50.9	9.5	62.3	2.4
1946....	258	26	284	118	52.3	8.0	64.0	5.7
1947....	433	37	470	173	81.0	12.1	97.6	15.4
1948....	529	39	568	185	102.4	11.1	<sup>2</sup> 116.8	11.4
1949....	558	45	603	123	99.3	16.0	<sup>2</sup> 117.2	6.6

SOURCE: *Production*: U. S. Bureau of the Census, Industry Division, FACTS FOR INDUSTRY, Series M37 A-07, *Tractors, 1948*, released 30 April 1949. *Exports*: U. S. Department of Commerce, Office of Domestic Commerce, Machinery Division, *Progress and Prospects in the Farm Equipment Industry*, by Robert Terry, 31 March 1949, data through 1947 for wheel and crawler tractors.

<sup>1</sup>Includes a small number of garden tractors.

<sup>2</sup>Includes used tractors. Excludes units over 95 hp.

<sup>3</sup>Includes 8,303 units in 1943 and 10,437 units in 1944 shipped under Lend-Lease.

are used on small farms for vegetables and other horticultural crops, roughly a third are employed on holdings of more than 20 hectares, usually as a supplement to a larger tractor. Another significant recent development is the growing popularity of the small agricultural tractor of between 6 and 18 drawbar horsepower. The special needs of a large group of farmers who had formerly depended largely on animal draft power because their farms were too small to make economic use of larger tractors are being met by these designs and the associated equipment. This development has accompanied a declining interest in animal-drawn equipment on the part of United States producers.

Table 10 shows that no very striking changes have occurred in the pattern of distribution of exports between various markets, with the main exceptions that the relative importance of the North American market itself has increased and that of Oceania has declined since the prewar period. These changes can be explained on the basis of the closer integration that has taken place between the industry in Canada and the United States and the greater dependence of Australia and New Zealand on domestic and other sterling sources of supply. The comparative rigidity of the pattern of distribution can be explained in part by the policy of manufacturers

Table 10.—UNITED STATES AND CANADA: FARM MACHINERY  
EXPORTS, PERCENTAGE DISTRIBUTION AMONG  
VARIOUS WORLD MARKETS, BY VALUE

Exporting country and year	Region of destination							
	North America	Europe	Latin America	Near East	Far East	Africa	Oceania	U.S.S.R.
	<i>( . . . . . Percent of value . . . . . )</i>							
United States:								
1937.....	25	16	28	1	3	10	17	—
1946.....	38	22	23	2	2	9	4	1
1947.....	32	20	26	2	3	10	6	1
1948.....	34	19	25	3	3	12	4	—
1949.....	38	14	19	6	5	12	6	—
Canada:								
1937.....	35	17	28	—	—	14	6	—
1946.....	51	27	8	4	1	9	1	—
1947.....	61	17	10	1	1	9	1	—
1948.....	72	12	6	2	1	7	...	—
1949.....	76	11	3	5	1	4	...	—

to export, during the early postwar years of inadequate supplies, only to traditional markets where dealers were established, together with maintenance facilities. Since 1948, when supplies had more nearly caught up with demand, some expansion into newly developed markets has been taking place, though often hampered by international exchange problems.

As pointed out in Part I, one of the outstanding problems in international trade in this field since World War II has been associated with the general problem of insufficient dollar exchange. Many importing areas have found it necessary to reduce imports from the United States and Canada, and seek alternative sources of supply. Some of the leading North American manufacturers have sought to overcome barriers of this kind by establishing branches abroad in the United Kingdom, France, Germany, and Australia.

### *Some Trends and Developments*

The long-term trend toward greater output per worker in the agriculture of North America has been referred to in Part I. Gross production per farm worker in the United States is shown in Table 11, together with some related data on employment.<sup>1</sup> It is clear from these figures that, for a modest increase in hours worked, output per worker increased by nearly 75 percent over the period cov-

<sup>1</sup>SOURCE: M. R. Cooper, G. T. Barton, and A. P. Brodell, *Progress of Farm Mechanization*, Misc. Publication 630, U. S. Department of Agriculture, 1947.

Table 11.—UNITED STATES: FARM EMPLOYMENT, MAN HOURS PER WORKER PER YEAR, AND GROSS PRODUCTION PER WORKER IN AGRICULTURE

Period	Average annual farm employment	Man-hours per worker per year	Gross production per worker
	<i>Million workers</i>	<i>Number</i>	<i>(Index: 1917-21 = 100)</i>
1909-13.....	12.1	1,840	88
1917-21.....	11.4	2,016	100
1927-31.....	11.2	1,976	108
1939.....	10.7	1,904	118
1942.....	10.4	2,032	142
1945.....	9.8	2,078	152

Table 12.—UNITED STATES: ESTIMATED LABOR SAVING IN  
FARM PRODUCTION RESULTING FROM CHANGES IN  
MECHANIZATION, CROP YIELDS, AND OTHER  
FACTORS, 1917-21 TO 1944

Factor	Man-hours saved in 1944	
	<i>Millions</i>	<i>Percent</i>
1. Increased mechanization and reduced horse and mule numbers.....	4,200	47
2. Increased yields of crops and livestock.....	1,700	19
3. Increased size of holdings, reduced overhead labor, and fuller use of work animals.....	1,850	21
4. Change in type of farming requiring more intensive labor.....	<sup>1</sup> —600	<sup>1</sup> —7
5. Miscellaneous: Simplified methods, hiring of equipment, etc.....	1,850	21
Sum of Factors 2-5.....	4,800	53
TOTAL.....	9,000	100

<sup>1</sup>Increase instead of saving.

ered, while the labor force declined by 19 percent. These changes, however, are attributable only in part to the more extensive use of machinery in farming, and in part to parallel changes affecting agricultural technology and other phases of economic development. The estimated saving in 1944 of man-hours of work in United States agriculture resulting from improvements in farm equipment and from other factors over the period 1917-21 to 1944 is analyzed in Table 12. The total of 9 thousand million man-hours is equivalent to a gain of more than 900 hours per worker per annum, or roughly 3 hours a day. It is clear, however, that less than half of this total resulted directly from greater use of machinery. Probably a part of the "increased yields" (Item 2 of Table 12) may be due to mechanization, but only a small proportion of it.

On turning to a breakdown of the types of equipment which have contributed to the reduced input of labor in agriculture ascribed to increased mechanization, some further important relationships are revealed (Table 13).<sup>2</sup> Direct savings resulting from farm

<sup>2</sup>Adapted from: M. R. Cooper, G. T. Barton, and A. P. Brodell, *Progress of Farm Mechanization*, Misc. Publication No. 630, U. S. Department of Agriculture, 1947.



mechanization and better farm equipment (1, 3, and 4) accounted for only 44 percent of the total; the complex item (2), representing labor savings due to the reduced care needed by machines as compared with animals, must be shared between tractors and other strictly farm equipment on the one hand and transport equipment in the shape of cars and trucks on the other. A particularly striking feature is that well over one-third of the economies in farm labor resulted from improved transport facilities (5 and part of 2). Over the approximately 25-year period covered by the data in Tables 12 and 13, therefore, it would appear that no more than a quarter of the gross saving in human labor could be attributed strictly to the introduction of more efficient farm machinery. The remaining three-quarters resulted from better management of farms, other technological advances, and more efficient farm transport.

These results in no way minimize the importance of improving farm equipment, but do point to the fact that if maximum benefit is to be derived from farm mechanization, it must be part of a broader development of the whole economic and technical setting of agriculture and not an isolated project. It must also be borne in mind that the relative contribution to greater output per man

Table 13.—UNITED STATES: APPROXIMATE IMPORTANCE OF  
VARIOUS TYPES OF MACHINES RESPONSIBLE FOR  
LABOR SAVINGS IN AGRICULTURE, 1917-21 TO 1944

Item	Approximate number of man-hours saved in 1944	
	<i>Millions</i>	<i>Percent</i>
1. Tractor-operated plows, cultivators, tillers, seeders, harvesters, combines, mowing machines, etc.....	940	22
2. Saving on work on horses and mules compared with tractor, truck, and automobile maintenance.....	880	21
3. Better small tools, horse-drawn equipment, gates, fencing, storage, etc.....	700	17
4. Milking machines.....	220	5
5. Farm automobiles and motortrucks.....	1,400	34
6. Others.....	60	1
TOTAL.....	4,200	100



*The horse-drawn reaper and binder still has a place in North American Agriculture.*

made by automobiles and trucks in this period has been much greater in the United States than elsewhere, partly on account of the great distances involved in that country and the exceptionally favorable conditions that prevail for the widespread use of motor vehicles, notably the low purchase price, cheap fuel, and an enormous public expenditure on roads.

The net effect of such striking increases in the productivity of farm labor has been to make possible increasing levels of agricultural production from expanded areas of farm land with a shrinking labor force. This is illustrated by the fact that the number of persons actively engaged in agriculture in the United States declined from 12 million in 1913 to less than 10 million in 1945. The trend is even more striking if traced over a longer period and if the farm labor force is expressed as a percentage of total employment figures. This displacement of farm workers has generally taken the form of a continuing movement from rural to urban employment. Only occasionally have there been serious maladjustments and distress as during the 1930's, when economic depression reduced the possibilities of urban employment for surplus farm population. In this period many families were "tractored off" their land. Special government action was necessary to assist some groups who lost their



source of livelihood through consolidation of small holdings and tenant farms into large units suitable for economic power farming.

One of the significant obstacles to the more rapid adoption of improved farm equipment is its high initial cost. For example, the capital investment involved in a typical two-plow tractor and the appropriate tillage and other land preparation implements was estimated at over \$2,500 in the United States at 1949 factory prices. If equipment for planting and harvesting grain and preparing and handling hay and other livestock feeds be added, the cost may approach \$10,000. As would be expected, experience in the United States has shown that sales of farm machinery to farmers are higher during periods of high farm income, as in the years during and after the two world wars, than during periods when farm income is depressed by low prices and reduced markets, as from 1930 to 1935. This has also been confirmed from Canada, where tractor sales in the western provinces totaled only 9,000 units between 1931 and 1936, compared with 60,000 units between 1921 and 1931. It is important to bear in mind that farm machinery prices fluctuated relatively little between 1920 and 1941, and rose less steeply than prices of farm products to about 70 percent above the 1939 level by the end of 1948. There is also evidence that machinery prices may not fall as sharply as farm prices on account of increased and relatively rigid costs of raw materials and labor.

With the prospect that farm income may decline from its high wartime and postwar levels, some slackening may be expected in the high rate of farm machinery sales, which added over two million tractors to the equipment of farms in the region between 1939 and 1949. In the United States a 10-percent decline in gross farm income in 1949 from the level of 1948 was reflected in a decline of some 15 percent in the value of farm machinery retail sales. Other factors, of course, were involved, such as the fulfillment of the backlog of demand and a somewhat more plentiful labor supply.

Machinery co-operatives have attracted much less support in North America than in parts of Europe as a device for spreading the heavy capital cost involved in a tractor or combine over a number of holdings. There has, however, been extensive practice of custom or contract use of machinery. In some areas not even the large landowners are able or willing to make the large investment required for the outright purchase of all the machinery they may need. Instead they make use of services provided by contractors,

particularly at peak periods as during the plowing and harvesting seasons. An outstanding example of this is the harvesting of the North American wheat crop by large numbers of privately owned combines which operate in a well-organized campaign each year, moving from south to north through the United States and into Canada as the grain ripens.

In both the United States and Canada, operation and maintenance of farm machinery are handled by the farmers themselves in co-operation with machinery dealers, who normally can supply spare parts from stock or from the factory at short notice and employ staffs of competent mechanics. Arrangements are made by most dealers for rapid delivery of urgently needed parts to minimize delays and keep machines in operation when they are needed most. Notwithstanding the rapidly accelerated rate at which tractors, combine harvesters, corn-pickers, hay-balers, and other complex machines have been adopted, there has been no apparent need for government assistance in the form of training schools for operators or repair depots. Agricultural colleges and extension services have, of course, given valuable instruction and advice to farmers, but no special measures have been necessary. Some problems have been reported as arising from the sale of untried machines, sometimes of defective design or workmanship, usually by new manufacturers anxious to secure quick sales in the sellers' market that existed during and after World War II. Competition among manufacturers has brought about progressive improvement of designs to eliminate defects and ensure more economical and efficient operation.

*In Oceania, teams of heavy draft horses are preferred to tractors by many farmers, where grazing land is abundant. Efficient modern implements are used, but capital investment in a tractor is avoided.*



# Europe

WITH 12 PERCENT of the world's arable land and 15 percent of the tractors, Europe is second only to North America in the total quantity of modern farm machinery in use. European producers accounted in 1948 for about one-quarter of world production of these items and of supplies entering international trade. The region is a substantial net exporter of farm equipment, but imports mainly heavy tractors, combines, and other large equipment from North America.

Farming in most countries of the region is on an advanced technological plane employing highly developed equipment suitable for animal and tractor power, although at present much of this equipment is old and of obsolescent design. There are also considerable areas in Eastern and Southern Europe where the wooden plow still persists, together with the flail and winnowing fork essentially similar to the equipment of the neighboring underdeveloped areas of Asia and North Africa. On the other hand, Western and Northern Europe include the most highly mechanized countries in the world, with an appreciably more intensive use of modern power-operated equipment than in the countries of North America and Oceania, considered as national units. There are many intermediate grades of development, and often advanced and backward methods exist side by side. Variations within the region are therefore considerable.<sup>3</sup>

## *Farm Machinery and Draft Power*

During World War II Europe lost over 15 percent of its draft animals, which before the war had contributed approximately 95

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<sup>3</sup>A number of subregions have been recognized, as follows:

- (a) Western Europe: Belgium, France, Ireland, Luxembourg, the Netherlands, Switzerland, and the United Kingdom.
- (b) Northern Europe: Denmark, Finland, Iceland, Norway, and Sweden.
- (c) Central Europe: Austria and Germany.
- (d) Eastern Europe: Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Rumania, Yugoslavia.
- (e) Mediterranean Europe: Greece, Italy, Portugal, Spain.

For some comparisons the United Kingdom—by far the greatest producer, user, and exporter of farm equipment in the region—is best separated from the rest of the continent, as in some of the tables in Part I. Turkey is sometimes considered as part of Europe, but is here included in the Near East.

percent of the farm power; and in 1949 total draft power had not yet reached its prewar level in all countries, although tractor numbers were more than double those in 1938/39 and draft animal numbers had increased appreciably from the low level of 1945. At the end of the war much of the region was also facing deficiencies in tractor- and horse-drawn plows, binders, sprayers, beet- and potato-harvesting machines, and even simple hand tools. Much worn and damaged machinery was unserviceable through lack of spare parts. The shortage of equipment and draft power was particularly marked in Eastern Europe, where proportionately greater losses had been suffered and where addition of tractors has been slower. The postwar shortage of draft power has been accompanied in many countries by a shortage of farm labor, e.g. in Austria, Czechoslovakia, France, and the United Kingdom.

Since 1946 the construction and restoration of factories and increasing supplies of raw materials and coal have permitted great expansion of Europe's output of farm equipment. Local production and the resumption of imports have done much to restore wartime losses, and many countries are engaged in vigorous programs for modernization of their agriculture to reduce dependence on imported food and raw materials.

Trends in tractor numbers in the various subregions are shown

Table 14.—EUROPE: TRACTOR DISTRIBUTION<sup>1</sup>

Subregion	Tractor inventories				1948 Arable land per tractor	Share of total arable land in Europe
	1939	July 1948	Est. July 1949	Target 1952		
	( . . . Thousand units . . . )				Hectares	Percent
Western Europe.....	112	366	434	635	182	22
Western Europe (excl. U. K.).....	(52)	(110)	(144)	(310)	(198)	(17)
Northern Europe.....	22	52	70	123	192	6
Central Europe.....	118	103	118	217	147	10
Eastern Europe.....	38	69	80	258	680	34
Mediterranean Europe....	46	76	82	106	500	28
TOTAL.....	335	666	784	1,339	210	100

<sup>1</sup>Based upon ECE Report E/ECE/IM/39, 14 April 1949, as revised August 1949. Garden tractors and, as far as possible, those used for industrial and other nonagricultural purposes are excluded.

in Table 14, together with data on tractor numbers in relation to the area of cultivated land. The high level of mechanization in Western, Northern, and Central Europe contrasts with the much lower levels in Eastern and Mediterranean Europe, which together have more than 60 percent of the cultivated area of the whole continent. It is also apparent that progress over the decade reviewed has been more rapid in Western and Northern Europe than in other areas.

### *Production of Farm Machinery*

As seen in Part I, there has been a great postwar increase in production of tractors and other farm machinery in Europe to meet

Table 15.—EUROPE: TRACTOR PRODUCTION<sup>1</sup>

Country and region	1934-38 <sup>2</sup>	1947 <sup>3</sup>	1948 <sup>3</sup>	Est. 1949
( . . . . . <i>Thousand units</i> . . . . . )				
Western Europe.....	19.1	66	132	111
France.....	1.3	6.0	12	17
Switzerland.....	1.3	2.0	3	4
United Kingdom.....	15.0	58	117	90
Northern Europe.....	0.3	3.0	4	4
Sweden.....	0.3	3.0	4	4
Central Europe.....	9.4	0.4	12	16
Austria.....	...	0.4	4	4
W. Germany.....	9.4	—	8	12
Eastern Europe.....	1.5	6.3	14	18
Czechoslovakia.....	0.5	6.0	9	10
Hungary.....	1.0	—	3	4
Poland.....	—	0.3	1	2
Romania.....	—	—	1	2
Mediterranean Europe.....	2.5	3.0	5	9
Italy.....	2.5	3.0	5	9
TOTAL.....	32.8	78.7	167	158

<sup>1</sup>Excludes garden tractors.

<sup>2</sup>Miscellaneous sources.

<sup>3</sup>Source: ECE Report E/ECE/1M/39, 14 April 1949, as revised August 1949.



internal needs and to supply export markets. Some details of tractor production are given in Table 15. The heavy concentration of the industry in Western Europe, particularly in the United Kingdom, is apparent. Plant capacity has been expanded considerably and, if fully utilized, could probably supply some 300,000 tractors a year, together with the appropriate implements, if markets were available.

### *Exports and Imports of Tractors and Farm Equipment*

Not only has domestic production of tractors and other farm equipment made great strides, but imports and exports of farm equipment have also increased greatly, as shown in Table 16.

Table 16.—VALUE OF FARM EQUIPMENT EXPORTS (INCLUDING TRACTORS) TO EUROPEAN COUNTRIES FROM MAJOR EXPORTING COUNTRIES<sup>1</sup>

Exporting country	1937	1946	1947	1948
( . . . . . Million U. S. dollars . . . . . )				
U. S. A.....	12.0	34.6	63.9	71.7
Canada.....	1.8	7.4	8.4	9.8
United Kingdom.....	3.0	17.8	21.2	44.1
Germany.....	8.4	—	—	—
Sweden.....	5.7	8.1	9.1	29.8
France.....	21.0	21.0	23.0	25.0
Switzerland.....	. . .	3.1	3.1	2.3
TOTAL.....	31.9	72.0	108.7	142.7

<sup>1</sup>Prices in country of origin; converted to U. S. dollars at official rates of exchange.

<sup>2</sup>Statistics not available; figures estimated.

Allowing for an approximate doubling in price between 1937 and 1948, it is evident that the volume of equipment involved has more than doubled. In respect of tractor numbers the increase is even more striking, the most important supplier to the rest of Europe at present being the United Kingdom, which supplied 27,000 units in 1948, i.e., roughly half the total imports. North America has also been an important source in the postwar period. The first twenty-two months of the European Recovery Program through May 1950 authorized the procurement from the United States and Canada of \$201 million worth of farm machinery and tractors by the 15 participating European countries, Turkey, West Germany, and dependent territories in Africa and the Far East. Actual shipments in this period

were valued at substantially less than this sum. This assistance, particularly in the case of heavier tractors than are commonly produced in Europe and some of the more complicated field equipment such as combine harvesters and hay balers, enabled modern efficient machinery to be supplied for larger farms at a time critical from the point of view of both food production and a shortage of dollar exchange.

By far the largest share of imported farm machinery has been going to the countries of Western and Northern Europe. Particularly since the termination of UNRRA aid, very small supplies have been taken by Eastern European and Mediterranean countries. Distribution of exports in 1948 from the major exporting countries is indicated in Table 17. These figures do not include substantial quantities of dairy equipment and other items from Sweden or supplies from France, Switzerland, Italy, and other exporting countries, but they account for nearly 90 percent of the total trade and a higher proportion of trade in tractors.

Table 17.—EUROPEAN DESTINATION OF EXPORTS FROM U. S. A., CANADA, AND UNITED KINGDOM, BY SUBREGIONS, 1948

Item	Unit	West. Europe <sup>1</sup>	North. Europe	Cent. Europe	East. Europe	Mediterr. Europe	Total
Farm equipment. (incl. tractors).	Million dollars	85.0	30.9	.4	2.2	7.1	125.6
Tractors.....	Thousand units	31.9	18.4	.1	.9	2.9	54.2

<sup>1</sup>Includes supplies received by the U. K. from U. S. A. and Canada.

A comparison of the tractor numbers planned for European agriculture with the productive capacity of the European tractor industry shows that well over 100,000 units a year may be available for export if factories are fully employed. This is nearly four times the number exported in 1948 and 1949 to overseas markets. The numbers of tractors from all sources, both European and non-European, entering these markets in those years are shown in Table 18. Of the total in 1949, 41,000 were from the United States and the residue of some 36,000 from European suppliers. The North American market has been deliberately excluded because, although it took 13,000 units from Europe in 1948, further imports of this order are improbable at least for some time despite what appears to be a growing market in Canada. Evidence available suggests that although the potential





*A green manure crop is turned under, using a tractor-drawn plow.*

demand in some of the areas listed may be considerable, these regions are unlikely in the next few years to take farm machines at a much higher rate than in 1948. Some shift to European sources of supply may be anticipated on account of continuing balance-of-payments problems with dollar areas, but with some exceptions the high prices and limited range of types of European machines will probably re-

Table 18.—DESTINATION OF TRACTOR EXPORTS FROM  
WORLD SOURCES, BY REGIONS, 1948 AND 1949<sup>1</sup>

Region	Tractor imports	
	1948	1949
	( . . . . Thousand units . . . . )	
Near East.....	3.9	7.0
Far East.....	3.1	4.5
Latin America.....	28.8	19.0
Oceania.....	18.1	29.0
Africa.....	21.6	18.6
TOTAL.....	75.5	77.6

<sup>1</sup>Excludes horticultural types.

strict their share of the total market, notwithstanding substantial currency devaluation. This is especially true in view of the huge productive capacity of U. S. manufacturers and the fact that domestic demand is now being readily satisfied in North America so that some downward adjustment of prices coupled with vigorous sales promotion may be anticipated.

It is clear that producers in Western Europe face a serious marketing problem, and conversely that large supplies of many items of farm equipment are likely to be readily available from soft currency areas for meeting the needs of importing countries.

Alternative outlets for the prospective surplus production are an accelerated rate of mechanization in Europe itself and vigorous action to arouse greater interest in improved equipment in overseas markets. Within the region itself the biggest potential market appears to be Eastern Europe, but, as seen above, this area has shown little tendency to buy farm machinery from either Western Europe or North America. Some of the measures that have been adopted by European governments to stimulate the introduction of more efficient farm equipment are dealt with in the next section. More intensive application of these and related measures, combined with reductions in the price of equipment through more economic production methods, may prove effective in increasing the rate of progress in farm mechanization within the region. As far as overseas markets are concerned, one of the most important requirements seems to be the establishment of more efficient sales and servicing organizations, prepared not only to sell and repair machinery but also to instruct drivers and

mechanics and undertake demonstration work. Low initial cost and low prices for spare parts and repair work are other essentials. Rationalization of sales policy between competing companies may in some cases be desirable so as to avoid the introduction of too many diverse makes and types into small markets and to ensure that appropriate implements and attachments accompany tractors. This may also help to overcome the difficulty of providing efficient sales and servicing organizations abroad, which is largely a result of the small volume of business done by each of several competing manufacturers in limited markets.

### ***Trends and Problems***

Many governments have adopted policies favoring the spread of more efficient farming methods in Europe through such measures as consolidation of holdings, special credits to farmers for the purchase of equipment, machinery co-operatives, contract services, training schools, and reduced taxation on tractor fuels. The aim underlying these measures is to secure greater productivity of farm labor, increased volume of agricultural production, and economies in production costs. The variety and complexity of these plans are too great to allow of a comprehensive analysis here, but the following discussion may serve to illustrate some of the major economic factors involved in raising the standard of agricultural equipment in a highly complex region like the European continent.

The progressive development of farm equipment in Europe has gone hand in hand with changes in the general economy of the region. One of the most striking results of these changes has been the rapid reduction, in industrialized countries, of the proportion of the population engaged in rural pursuits. In part this has been due to a growing dependence for agricultural products on overseas sources of supply, but in large part it has resulted from the greatly increased efficiency of the farmer. As in the case of North America, the reduction in man-hours required for agricultural production cannot be attributed wholly to more efficient farm machinery, as there have been improvements in other factors of production, but the advantages conferred in this respect by more highly developed machinery have been a strong incentive for its introduction. This has been particularly true on larger holdings where the work cannot all be performed by the family and where the farm income is adequate to warrant the heavy capital

investment involved in the more elaborate types of equipment.

The small size and fragmentation of holdings in many parts of Europe have been a major obstacle to the more rapid spread of large machinery. Economic operation of machinery is to a large extent dependent on a high degree of utilization. This can be secured only on a holding of sufficient size or by using a piece of equipment on more than one holding by such devices as co-operative or contract use. The greater efficiency of labor on the larger farm unit as compared with its smaller counterpart in the same region is illustrated by the following figures collected in England in 1942 and 1943. They show the output per worker on 262 typical mixed farms of various sizes in the Midlands.<sup>4</sup> These figures are largely a reflection of the fact that larger holdings lend themselves more readily to mechanization than smaller operating units.

<i>Size of farm</i> ( <i>Hectares</i> )	<i>Output per worker</i> ( <i>Percentage of Optimum</i> )
7-10.....	42
10-20.....	48
20-30.....	59
60-160.....	93
Over 160.....	100

Many European governments have realized that, to stimulate the better equipment of farms and to raise the output of labor, measures are necessary to overcome the serious impediment of small operating units. In northern France, for example, *morcellement* of holdings has frequently resulted in fields as small as one twenty-fifth of a hectare. Ever since World War I legislative attempts have been made in France to improve the situation, with the result that, by 1948, holdings surrounding more than 400 villages had been re-grouped.<sup>5</sup>

Other areas seriously handicapped in the mechanization of their agriculture by uneconomic subdivision of land include countries of Eastern Europe. Bulgaria, Hungary, Romania, and Yugoslavia are concentrating on variants of a co-operative system. In Bulgaria,

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<sup>4</sup>SOURCE: F. W. Bateson, *Towards a Socialist Agriculture*, Ch. V, London, 1946.

<sup>5</sup>SOURCE: *The Farm Economist*, Vol. VI, No. 3, 1949.



farmers are being induced to co-operate by easy state credits to co-operatives, cheap improved seed, priority for machinery, use of tractors from state tractor stations at low rates, and other similar measures.<sup>6</sup> In Yugoslavia, the co-operative pays rent to owners who pool their land; members work on pooled land for wages, but retain a small area for themselves for a home garden and a few livestock. Romania is reported to be establishing collective farms to be served by machine tractor depots.

Co-operative and contract arrangements of various types have been developed over a long period, particularly in Northern Europe, as a means of bringing the benefits of improved mechanization to farmers who lack the land and capital to warrant full individual ownership. This movement has been actively fostered by many governments during the wartime and postwar food emergencies. A frequent feature, for example, of national machinery schemes connected with the European Recovery Program has been priority to co-operative and collective purchases of equipment imported under the program, sometimes accompanied by provision of special credits. In Denmark, farmers have for many years made extensive use of these methods; the private contractor with tractors and implements is engaged by the small holder as required for various tillage and harvesting operations, while in other instances groups of farmers combine to purchase equipment too expensive for any one landowner to use economically. Similar co-operatives in Sweden have received official support from a special machinery loan fund to finance the purchase of machinery. In Switzerland co-operatives were, in the war years, granted up to 60 percent of the price of equipment as subsidy by federal and local authorities. Somewhat similar subsidies are reported in Austria, where the government pays up to 50 percent of the cost of specified labor-saving and production-raising agricultural machinery, giving priority to collective purchases by several farmers. In Italy 40 percent of the purchase price of machinery and implements may be granted to small operating farmers and tenants in southern districts by the government, and 33 percent of the value of equipment needed for breaking new land.

The employment under contract of the service of expensive machinery such as threshers, combine harvesters, and tractors has been a long-standing feature of farming practices in many parts of the region. This movement has also received considerable impetus

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<sup>6</sup>*The Economist*, 13 Aug. and 30 Aug. 1949.

in recent years. A particularly successful service of this type, provided partly at public expense to assist farmers to secure maximum efficiency in production, is the U. K. Agricultural Machinery Service of the County Agricultural Committees, which grew up during World War II. Equipped in 1949 with 10,000 tractors and tractor plows, 6,400 binders, 1,000 threshing machines, and 375 combine harvesters, the Service operates in 61 counties under the supervision of government machinery officers. Eight to ten tractors with drivers are under a foreman; repair work is undertaken by mechanics at repair depots, of which there is at least one in each county. The machinery service covers: contract work undertaken for farmers who cannot do their own work or cannot obtain the services of private contractors; hire of machinery to farmers and contractors to supplement their own resources; work on land farmed by County Agricultural Executive Committees.

By their nature these services involve a large number of often minor tasks at many points, work on difficult land, and maintenance of a reserve of men and machines all the year round, so that the service is operated under adverse economic conditions. The charges made to farmers do not completely cover operating costs, but have been selected as representing a fair charge. Through this service it has been possible to keep many areas under crop, and this was considered to justify the expenditure of public money during the war and postwar periods, but the service has been reduced as farmers have obtained additional equipment of their own.

A serious problem encountered in the application of power-farming methods in Europe is associated with the supply and cost of fuel. On the basis of an average annual consumption per tractor of five tons of petroleum, the addition of 450,000 tractors in the decade 1939-49 has increased the requirement of refined petroleum products by nearly 2.5 million tons per year. This involves a significant increase in oil imports, mainly from hard currency areas. It is also evident that improved local distribution facilities become necessary as the use of power-operated machinery spreads in rural areas. Not only must tractors, combines, and stationary farm engines be considered, but also motor trucks for farm transport. Various government measures have been adopted to assist farmers, such as reduced taxation on tractor fuels. Considerable interest is displayed in alternative fuels, such as the substitution of producer gas for oil. Rural electrification is promoting the use of electric motors for stationary equipment,



and designers in Sweden, Switzerland, and the United Kingdom as well as in the U. S. S. R. are reported to be developing electric tractors.

As pointed out above, shortage of spare parts was a critical factor in reducing the serviceability of farm machinery in many parts of Europe during and after World War II. At one stage it was reported, for instance, that nearly half the total tractor force in Hungary was idle. Although this crisis in spare parts has been overcome, the question of maintenance of much of the mechanical equipment in use in Europe continues to be complicated by the great variety of makes and types produced now and in the past. Reference has been made in Part I to active steps being taken to secure a greater degree of standardization. One example of this is provided by Belgium, where the Belgian Institute for Standardization has under its auspices a special commission dealing with farm machines manufactured in Belgium. All implements used in the tillage of the soil are now made according to a set of standards. Similar action is being undertaken for other agricultural machinery.

Closely related to the question of spare parts and maintenance is that of properly trained operators and mechanics. This matter has received the attention of a number of governments. A few examples recently reported to FAO will serve to illustrate the type of organization found to be helpful in some countries. In Greece some modern equipment has been in use for many years, but wartime losses of draft animals and various forms of foreign aid have led to a recent acceleration in the rate of farm mechanization, and it has been found that dealers do not furnish the full services needed. The Ministry of Agriculture has, therefore, organized traveling schools for the training of operators and mechanics. In 1948 about 30 traveling schools visited some 100 places, training tractor drivers in twelve-day courses. There is also a traveling school for thresher operators which gives a three-day course of instruction. It is planned to open four schools for the training of mechanics. In Poland the vigorous agricultural program includes a plan for the rapid spread of mechanization. One feature of this plan is a training school near Danzig, to train some 5,000 persons as farm machinery mechanics and tractor drivers in three- to six-month courses. The government subsidizes this school, and trainees pay only a small fee for board. Further, there are various government and farmers' organizations which give farmers technical advice on the use of machinery. Other countries



*A variant of mechanized grain harvesting and threshing is suited to moist climates (France). Use of expensive machinery reduces labor requirement.*

where government-subsidized courses are available are Austria, Czechoslovakia, and Italy.

By contrast, no government training programs or specially organized schools have been found necessary in countries with a generally high level of technology, such as Switzerland, the Netherlands, and the United Kingdom, although in some of these countries the rate of mechanization has expanded very rapidly in recent years. It is in comparatively underdeveloped areas that the normal commercial services and the guidance provided by regular educational and extension services are likely to prove inadequate.

# U. S. S. R.

THE U. S. S. R. affords the classic example of a planned transition from one level of development in farming to another level. Within the decade from 1928 to 1938 the agriculture of the region was in large measure transformed from a peasant system employing hand and animal tools to a collectivized system heavily dependent on tractors for tillage and on combines for harvesting, though still requiring much hand labor and employing many relatively backward techniques and implements for other farm operations. The invasion in World War II of a large part of the best agricultural land and destruction of much of the equipment was a serious setback from which full recovery will take a long time as important factories were destroyed at Stalingrad and elsewhere. Nevertheless, the U. S. S. R., with 10 percent of the world's tractors on 18 percent of the arable land in 1948/49, was exceeded in tractor numbers per unit area of cultivated land only by North America, Europe, and Oceania and was far ahead in this respect of Latin America, South Asia, and Africa. When it is considered that, according to official Soviet reports, collective management results in 50 to 100 percent higher utilization rates of the avail-

Table 19.—U.S.S.R.: FARM MACHINERY IN USE, SELECTED YEARS

Type of machine	1928 <sup>1</sup>	1938 <sup>1</sup>	1940 <sup>1</sup>	1945	1949 <sup>2</sup>
	( . . . . . Thousand units . . . . . )				
Tractors.....	27	484	523	3386	4525
Plows:					
Primitive.....	4,600	..	..	..	..
Modern horse.....	14,000	5,500	..	..	..
Modern tractor.....	9	494	..	..	..
Seed drills:					
Horse.....	718	676	..	..	..
Tractor.....	1	266	..	..	..
Grain harvesters:					
Combines.....	0	154	182	3133	..
Binders, horse.....	54	44	..	..	..
Binders, tractor.....	—	11	..	..	..
Threshing machines.....	6	131	..	..	..
Beet harvesters.....	0	19	..	..	..
Trucks.....	1	196	..	..	..

<sup>1</sup>From official sources.

<sup>2</sup>Postwar boundaries.

<sup>3</sup>1940 total reduced by reported wartime losses. Manufacture was greatly reduced and probably replaced only normal wastage.

<sup>4</sup>Reported by the United Nations Economic Commission for Europe.

able machinery in this region than in any other major region on which information is available, it becomes clear that the U. S. S. R., which twenty years ago would certainly have been classed as underdeveloped in respect of farm equipment, now has a definite place among the areas of the world progressing rapidly in the use of power machinery.

Some idea of the magnitude of the transition achieved during the first two Five Year Plans is given by the statistics on machinery in use in 1928 and 1938 quoted in Table 19. During this period, draft animals declined from 29 million to 13.6 million in terms of horse units. Table 19 also shows the effect of heavy wartime losses of major items of farm equipment and gives an indication of the rate of postwar recovery.

One of the most fundamental changes made in Soviet agriculture has been the collectivization and replanning of agricultural land into large state and collective farms. The latter are served by machine tractor stations, which were set up in rapidly increasing numbers after 1928 as collectivization proceeded and the replacement of primitive and obsolete equipment gathered momentum. Table 20 shows the growth of these stations in numbers and in equipment and personnel up to the outbreak of war in 1940, when over 7,000 had been set up, with an average of about 60 tractors each and a total staff of 1.5 million persons, 10 percent of whom were engineers and repair-shop workers. The inclusion of additional territory within

Table 20.—U.S.S.R.: GROWTH OF MACHINE TRACTOR STATIONS, 1932-40<sup>1</sup>

Item	1932	1938	1940
	( . . . . . Thousands . . . . . )		
Number of MTS.....	2.45	6.36	7.07
Equipment:			
Tractors.....	75	394	435
Combines.....	2	127	153
Trucks.....	6	75	40
Personnel:.....		1,403	. . .
Tractor drivers.....		685	. . .
Repair shop workers.....		99	. . .
Engineers.....		40	. . .
Tractor brigadiers.....		96	. . .

<sup>1</sup>From official Soviet sources.



the U. S. S. R. has led to further extension of this type of organization. The fourth Five Year Plan proposed the construction of 950 new machine tractor stations between 1946 and 1950 to restore wartime losses and provide the desired expansion.

In the early stages of the intensive farm mechanization program, most tractors and other equipment were imported, mainly from the United States. But as the program progressed, the machinery supplied to Soviet agriculture was increasingly provided by local industry. In 1933, imports of agricultural machinery, which in 1929 had totaled 80,000 tons, had fallen to less than 3,000 tons. By 1938 they had virtually disappeared, and 7,600 tons of farm equipment were exported in this year to neighboring Baltic countries and to Turkey, Iran, and Denmark. After the war, small imports were made through UNRRA; but despite the extremely heavy losses of both equipment and plant capacity, reconstruction of agriculture has depended almost entirely on restoration of local production.

Tractor production in the U. S. S. R. started in a small way in 1923. Trends in output are shown by the following figures:

<i>Year</i>	<i>Number of tractors produced</i>
	<i>Thousand units</i>
1928 <sup>1</sup> .....	1.2
1932 <sup>1</sup> .....	51
1936 <sup>1</sup> .....	116
1946 <sup>2</sup> .....	16
1947 <sup>2</sup> .....	34
1948 <sup>2</sup> .....	67
1949 <sup>2</sup> .....	90
1950 (Target) <sup>1</sup> .....	112

<sup>1</sup>Official figures.

<sup>2</sup>Estimates based on official statements.

As these figures indicate, plans provide for restoring prewar levels of tractor production in 1950. Manufacture of associated equipment has kept pace with that of tractors. For example, the target figures published by the Ministry of Farm Machinery Production for 1948 included 220,000 tractor- and horse-drawn plows, 25,000 harvester combines, and 116,000 seeders. It is officially stated that production approximated these goals.

Postwar supplies for export have naturally been very limited, though some equipment is reported to have been provided to Eastern Europe. In a few years, however, the U. S. S. R. may become an important exporter of certain items of farm equipment to neighboring countries.

The progress of farm mechanization in the U. S. S. R. cannot strictly be compared with that in other regions because of the special conditions that exist. In its initial phases, the program represented part of a concerted national effort to secure adequate food supply to the towns, threatened by a serious crisis following the destruction of the old system of individual small holdings and the phenomenal loss of work animals which accompanied this change. It is significant that, in its initial phases, mechanization was directed mainly at tillage, seeding, and harvesting of bread grains. The primary emphasis was on working maximum areas, rather than on saving labor and reducing costs of operations. A different set of economic circumstances was therefore operating from those normally at work in most other regions. The fact that large reductions in the farm labor force were made possible (see Table 21) is more an incidental result than a determining factor in the introduction of machinery and reorganization of agriculture.

Table 21.—U.S.S.R.: LABOR SAVING ON COLLECTIVE FARMS  
THROUGH USE OF TRACTORS AND COMBINES, 1937<sup>1</sup>

Labor input and savings	Million workdays
Labor input:	
A. Actual, using machines from MTS, 1937.....	220.8
B. Estimated, if the same operations were performed by horses and hand labor.....	1,070.6
C. Estimated, if the same operations were performed by individual peasants.....	1,505.8
Labor savings:	
A as compared with B.....	849.8
A as compared with C.....	1,285.0

<sup>1</sup>Based on *Socialist Agriculture U.S.S.R., 1938*, Gosplan (Moscow, 1939).

Recent developments have been toward more varied designs of machines and mechanization of a greater variety of crops, e.g., flax and sugar beets. A wider range of farm operations is likely to be mechanized as agriculture recovers from the severe setback received during the war. It may be anticipated that, with more versatile machinery and greater refinement in technique of crop mechanization, the large labor force now found necessary will be significantly reduced.



## *Latin America*

LATIN AMERICA as a whole represents an intermediate state between the highly mechanized countries of Western Europe, North America, and Oceania on the one hand and such areas as the Near East and the Far East on the other, where farming is still performed almost entirely with the aid of simple hand and animal implements. With some 9 percent of the world's arable land, Latin America had in 1948 roughly 1.5 percent of the tractors in use in the world. These figures give an indication of the relative level of mechanization of the region, though there are great variations from country to country and from area to area within individual countries. This region exhibits great contrasts in the levels of agricultural technology. The subsistence farmers, who make up a large proportion of the population in many countries of the region, usually have equipment of the simplest and crudest kind; at the other end of the scale, the larger estates and commercial grain and sugar-producing areas may employ the most modern power-operated machines. There are many intermediate stages, including the wooden plow and the iron or steel European type animal-drawn plow.

### *Imports of Farm Equipment*

Factory production within the region supplies only a small part of the needs for relatively simple machinery. A large proportion of the hand and animal tools and the bulk of the modern machines and implements are imported from North America and Europe. For many years the region has been one of the largest export markets for farm equipment, and in the postwar years it has absorbed roughly 20 percent of the total value of tractors and farm machinery entering world trade. There is no doubt that considerable scope exists for further progress; and now that production in exporting countries has caught up with demand, no special difficulties should be encountered in supplying the needs of the region. In common with many other areas, however, balance-of-payment difficulties are placing limitations on the amount of machinery many of the Latin-American countries are prepared to import.

The estimated number of tractors in use and the recent rate of export to the region from the main suppliers appear in Table 22.

Table 22.—LATIN AMERICA: TRACTOR POSITION<sup>1</sup>

Country of destination	Estimated numbers of tractors in use <sup>2</sup>		Tractor exports to region from United States, United Kingdom, and Canada				
	1948 <sup>3</sup>	1949	1937	1946	1947	1948	1949
	( . . . . . Units . . . . . )						
Argentina.....	18,777	23,910	3,681	1,197	5,246	7,480	631
Bolivia.....	579	603	7	109	85	96	194
Brazil.....	4,672	6,189	434	668	1,692	2,101	4,217
British Guiana.....		170	6	10	45	116	216
Chile.....	4,143	5,046	150	681	747	1,421	1,128
Colombia.....	2,795	3,214	198	314	792	768	1,196
Ecuador.....	549	594	19	120	113	114	148
Paraguay.....	55	138	—	6	37	90	99
Peru.....	2,343	2,491	266	235	399	441	777
Uruguay.....	2,890	7,005	464	305	977	4,476	804
Venezuela.....	4,403	5,448	84	662	1,545	1,595	1,561
British West Indies..		600	27	158	180	227	193
Costa Rica.....	392	372	2	71	51	29	65
Cuba.....	3,515	4,975	86	772	1,565	1,900	1,638
Dominican Republic..	297	419	11	110	137	159	110
El Salvador.....	298	304	8	78	128	43	72
Guatemala.....	631	639	14	150	156	87	67
Haiti.....	44	40					26
Honduras.....	233	279	4	40	107	75	51
French West Indies..		165	4	27	23	115	134
Mexico.....	17,035	21,964	833	3,214	5,294	7,059	5,513
Nicaragua.....	255	315	2	69	55	92	128
Panama.....	268	283	7	48	63	49	57
Other.....			37	102	114	144	145
TOTAL <sup>4</sup> .....	64,174	85,163	6,344	9,146	19,551	28,677	18,970

<sup>1</sup>Excludes garden tractors where these can be distinguished. Includes wheel and crawler tractors for all purposes, including nonagricultural uses. Compiled from official statistics.

<sup>2</sup>Refers to the beginning of the year.

<sup>3</sup>From Joint ECLA-FAO Working Party Report.

<sup>4</sup>Added total of available data.

The total value of farm machinery exports to the region is presented in Table 23. The big postwar increase in the value of these exports is apparent. As the increase in price over the decade in the main supplying countries was of the order of 60 percent, the volume of farm machinery supplied to the region in 1948 was about three times the 1937 volume. The larger fraction of the total value of equipment accounted for by tractors in the postwar period indicates the trend toward power-farming methods. A fea-

Table 23.—VALUE OF FARM MACHINERY EXPORTS TO LATIN AMERICA FROM UNITED STATES, UNITED KINGDOM, AND CANADA<sup>1</sup>  
(INCLUDING AND EXCLUDING TRACTORS)

Country of destination	1937		1946		1947		1948	
	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors
( . . . . . Million U. S. dollars . . . . . )								
Argentina.....	14.2	10.1	5.1	3.4	26.6	15.6	20.3	7.3
Bolivia.....	—	—	0.5	0.2	0.4	0.2	0.5	0.2
Brazil.....	1.6	0.9	3.8	1.6	9.1	4.3	11.1	5.1
British Guiana.....	—	—	0.1	0.1	0.4	0.3	0.8	0.5
Chili.....	0.8	0.6	2.3	1.2	4.1	2.7	7.0	4.2
Colombia.....	0.6	0.3	1.9	1.1	4.3	2.2	4.9	2.7
Ecuador.....	0.1	—	0.6	0.2	0.8	0.4	0.8	0.4
Peru.....	0.7	0.3	0.9	0.4	1.8	1.0	1.9	1.0
Paraguay.....	—	—	0.1	0.1	0.2	0.1	0.4	0.1
Uruguay.....	1.2	0.8	1.1	0.7	3.3	2.2	11.2	5.5
Venezuela.....	0.5	0.2	3.5	1.7	10.1	4.8	12.7	5.7
British West Indies...	0.1	—	0.6	0.2	1.1	0.6	1.5	0.8
Cuba.....	0.4	0.2	2.2	0.8	5.2	2.7	5.9	2.6
Dominican Republic...	0.1	0.1	0.6	0.2	1.0	0.5	1.0	0.4
Costa Rica.....	—	—	0.3	0.1	0.5	0.4	0.3	0.2
El Salvador.....	0.1	0.1	0.2	0.1	0.5	0.3	0.5	0.4
Guatemala.....	0.1	0.1	0.3	0.1	0.7	0.4	0.7	0.4
Honduras.....	—	—	0.2	0.1	0.6	0.3	0.5	0.2
French West Indies...	—	—	0.2	0.1	0.1	—	0.7	0.2
Mexico.....	3.3	1.8	11.8	6.5	18.8	9.7	25.9	13.4
Nicaragua.....	—	—	0.3	0.1	0.5	0.3	0.5	0.3
Panama.....	0.1	0.1	0.4	0.2	0.6	0.4	0.5	0.3
Other.....	0.3	0.1	1.3	0.8	1.2	0.6	2.0	1.1
TOTAL.....	24.2	15.7	38.3	20.0	91.9	50.0	111.6	53.0

<sup>1</sup>Priced at ports in the exporting countries. Freight and handling charges should be added to obtain landed cost. Compiled from official export statistics.

ture of recent years has been the increasing proportion of supplies received from European sources, notably the United Kingdom in 1948, as shown by the data for the region as a whole assembled in Table 24. It will be noted that 90 percent of supplies imported in that year were from the dollar area. (See also Table 6.)

There is evidence that purchases from dollar sources have been appreciably curtailed by lack of the necessary exchange in many countries, particularly in Peru, Argentina, and some Central American republics. Loans have been made by the U. S. Export-Import Bank to Guatemala, Colombia, Chile, and Paraguay for the purchase of agricultural machines. Two of the three dollar loans made

Table 24.—VALUE OF FARM MACHINERY EXPORTS TO LATIN AMERICA, BY COUNTRIES OF ORIGIN

Country of origin	1937	1946	1947	1948	1949
	( . . . . . Million U. S. dollars . . . . . )				
United States.....	21.0	35.9	83.8	96.4	83.2
Canada.....	3.0	2.1	4.8	5.0	3.1
United Kingdom.....	0.2	0.3	3.3	10.2	5.8
Germany.....	1.3	—	—	—	—
Sweden.....	0.3	1.0	1.0	...	...
Switzerland.....	—	—	0.1	0.2	...

before 1950 by the International Bank for Reconstruction and Development have also gone to Latin America. The first of these, for \$2.5 million, went to the Corporación de Fomento de la Producción in Chile,<sup>7</sup> its main objectives being to decrease the cost of agricultural production by replacing oxen with tractors, to clear forest land, and to harvest crops more efficiently. The second loan, for \$5 million, was made to the Caja de Crédito Agrario, Industrial y Minero of Colombia, for tractors, tractor- and animal-drawn implements, hand tools, spare parts, and repair installations to increase farm production and reduce food imports from hard currency areas.\*

### Local Production of Farm Equipment

Only fragmentary statistics are available on domestic production of farm equipment within the region. Factories have been established in Argentina, Brazil, Chile, and Mexico, but, as pointed out above, production is limited, and is mainly confined to hand and animal implements. It is extremely important in a region of this type, where a large proportion of production is carried out on small holdings, that simple tools should not be neglected in promoting higher levels of agricultural production. Improvement in the design and materials of this class of implements could have marked effects in improving the efficiency of labor. Local industry would be making a most valuable contribution by concentrating on this

<sup>7</sup>IBRD Press Release No. 86, 25 March 1948.

\*IBRD Press Release No. 146, 19 August 1949.

field, with a view to producing serviceable low-priced tools specially adapted to local needs.

### ***Trends and Prospects***

None of the Latin-American countries can be regarded as having a highly mechanized agriculture; much of the equipment in use is still quite simple, and modern machines are employed only on certain crops and on a limited number of operations in their cultivation. In most countries of the region there is a preponderance of small farmers without sufficient capital or knowledge to employ improved implements.

Farm wage rates are generally quite low; and where abundant cheap labor is available, hand methods may prove more economic than heavy mechanization. This is claimed in the case of rice harvesting in Brazil, where the method of reaping with the sickle, stacking and threshing has proved in some areas to be cheaper than the use of expensive imported combines.

However, growing industrialization is increasing urban employment in some countries, and the resultant withdrawal of rural labor and the rising wage trend are stimulating interest in the use of labor-saving machinery. Tractor farming has made most progress in Mexico, Venezuela, and Cuba (map, pp. 6-7). In the first two cases, indigenous fuel supply and adequate dollar earnings to permit imports from North America are favorable factors; in Cuba, commercial production of sugar, mainly for export to the United States, ensures ample dollar exchange. The limited cultivated areas of the coastal belt of Peru are relatively highly mechanized, but shortage of dollars has proved a handicap. Other countries where considerable progress has been made are Chile and Argentina. In Chile there is considerable wealth derived from mining and in some areas a labor shortage, while Argentina has extensive areas with large holdings and ideal terrain for heavy machinery. Though much of the equipment employed in commercial farming in Argentina is of modern type, the tractor is not very extensively used, because horses can be bought and maintained cheaply and many farmers lack the necessary capital to buy the fairly powerful tractors that give best results under local conditions.

The Joint ECLA-FAO Working Party in 1949 drew attention to many salient factors influencing the economic use of farm machinery in the region. It pointed out the need for improved credit



facilities to farmers; for extension of contract services to bring the benefits of modern equipment to smaller holdings; for better education and demonstration facilities to farmers; and for training of mechanics and operators and provision of local repair shops. Progress in these directions would do much to increase the use of more efficient farm equipment. Other factors hampering its wider adoption are the high initial cost of imported equipment, often greatly increased by ocean freight rates, transport costs from ports to the interior, and dealers' charges.

The usual form of commercial credit offered in this region by machinery dealers is stated to require a cash deposit of 25 to 50 percent of the total price, strong guarantees or securities, high interest rates (e.g., 12 percent), and total payment within 90 days to a year. The ordinary farmer, with only his land and crops to offer as security, cannot under these conditions afford the heavy investment involved in farm machinery which would have a normal operating life of 8 to 10 years and would not result in immediate increases in his income of the order needed to repay loans on these terms. Within the last decade, governments have been increasingly aware of the need to assist farmers with longer-term credits if they are to benefit from the more economic production made possible by better mechanization. Action taken along these lines in Argentina, Chile, Uruguay, Colombia, and Mexico was briefly described by the Joint ECLA-FAO Working Party. Two to three years for repayment, 25 to 30 percent down payment, and 5 to 6 percent interest are typical terms of mechanization loans made through such bodies as the Banco de la Republica in Uruguay, the Caja de Crédito Agrario in Chile, and the Crédito Agrario Industrial y Minero in Colombia. These terms represent marked concessions on normal commercial practice in this region. Unfortunately, in some cases the funds allotted to these various financial agencies have been insufficient to meet the demand from eligible farmers, who are then obliged to seek less favorable commercial credits or forego the benefits of improving their farms.

There has also been a tendency in recent years in Latin-American countries for machinery contract services to be organized, both for the benefit of the small farmer and for the larger landholder who lacks the technical knowledge to use machinery effectively.<sup>9</sup> For

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<sup>9</sup>Joint ECLA-FAO Working Party Report, 1949.



example, the Corporación de Fomento in Chile and the Banco Nacional de Crédito Ejidal in Mexico have established such services. Government services exist in Peru, Guatemala, and the Dominican Republic, while in Brazil government funds have been made available to encourage private contractors. In the Dominican Republic, 68 tractors were available in 1948 for hire to farmers, and the service was proving so successful that its expansion to include over 300 tractors with appropriate equipment was proposed.

There is no doubt that growing urban populations, together with the restrictions imposed on agricultural land resources by climate and the mountainous terrain of many Latin-American countries, will necessitate the introduction of better agricultural practices in order to obtain the maximum return from the available land. In all countries of the region efficient equipment, carefully selected for local conditions, can make important contributions to better and more timely tillage, planting, and harvesting operations, while in some of them machinery is needed for land clearing and the construction of effective soil conservation works.

*Tractor with mounted power-driven mower gives ease of handling and speedy operation with minimum labor requirement.*



## Near East

THE INDIGENOUS AGRICULTURE of the Near East depends on the use of hand tools, supplemented by animal-drawn equipment of simple design such as the wooden plow and the *norag* or bullock-drawn threshing machine. In some areas, however, long association with the industrialized countries of Western Europe, and more recently with North America, has led to the introduction of steel plows to replace the locally made type, and in many countries power-operated equipment has been successfully applied on larger holdings.

There are several factors in the region especially conducive to a rapid but somewhat restricted adoption of tractors, combine harvesters, and other large modern machines; these include sparse population in some countries and a resultant growing shortage of farm labor, the presence in some parts of the region of abundant supplies of petroleum products, the existence of dollar and sterling reserves in some countries, and the substantial proportion of the land that is in large holdings. But, though rather rapid progress has been made in recent years, the level of modern mechanization so far attained is low. With some 6 percent of the world's arable land, the region had no more than 0.3 percent of the world's tractors in 1948. Local industry largely supplies the traditional equipment of the small farmer, but most of the improved animal-drawn implements required and all tractors and associated implements are imported. The fact that only 2.5 percent of these types of equipment entering world trade in 1948 was taken by the countries of this region indicates the low rate at which farm machinery is being introduced. This, in the absence of local production of these items, represents only 0.5 percent of world output.

### *Imports of Modern Farm Equipment*

The estimated number of tractors in use and the recent rate of exports of tractors to the region are shown in Table 25. In the region as a whole there is a marked preference for tractors of fairly heavy type. Associated implements are naturally also of heavy type, and there is some demand for large seeding and harvesting equipment, including combines.

Table 25.—NEAR EAST: TRACTOR POSITION<sup>1</sup>

Country	Estimated tractor fleet 1948	Tractor exports to region from United States and United Kingdom				
		1937	1946	1947	1948	1949
	( . . . . . )	<i>Units</i> . . . . .				
Afghanistan.....	20	—	—	8	9	3
Egypt.....	5,400	224	552	673	1,432	1,511
Ethiopia.....	30	—	—	27	4	2
Iran.....	550	5	128	137	239	415
Iraq.....	450	17	65	127	105	168
Israel.....	800	55	179	203	210	<sup>2</sup> 1,480
Lebanon.....	180	—	—	15	153	182
Saudi Arabia.....	140	1	3	80	50	12
Syria.....	300	22	53	174	35	69
Turkey.....	2,900	74	202	472	1,590	<sup>2</sup> 3,082
Other.....	200	—	8	93	81	119
TOTAL.....	10,970	398	1,190	2,009	3,908	7,043

<sup>1</sup>Excludes garden tractors. Includes all other types for both agricultural and nonagricultural purposes.

<sup>2</sup>Includes small numbers of tractors from Canada.

Table 26.—VALUE OF FARM MACHINERY EXPORTS TO NEAR EASTERN COUNTRIES, BY SOURCE

Source and destination	Sum of farm machinery exports to Near East							
	1937		1946		1947		1948	
	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors
	<i>( . . . . . Million U. S. dollars . . . . . )</i>							
From U. S., U. K., and Canada to:								
Afghanistan.....	—	—	—	—	0.1	—	0.1	0.1
Egypt.....	0.5	0.2	1.4	0.7	1.7	0.7	3.2	1.2
Ethiopia.....	—	—	—	—	0.1	0.1	—	—
Iran.....	—	—	0.2	—	0.5	0.2	1.2	0.4
Iraq.....	—	—	0.3	0.1	0.6	0.3	1.2	0.9
Israel.....	0.2	0.1	1.1	0.6	2.3	1.4	1.8	1.2
Lebanon.....	—	—	—	—	0.1	0.1	0.9	0.4
Saudi Arabia.....	—	—	0.1	0.1	1.3	0.5	1.3	0.8
Syria.....	0.1	—	0.3	0.1	1.4	0.6	0.3	0.1
Turkey.....	0.3	0.1	1.5	1.3	1.2	0.6	6.2	2.9
Other.....	0.2	0.2	0.2	0.2	0.7	0.4	0.3	0.1
From other sources...	0.5	0.5	0.2	0.2	0.2	0.4	0.3	0.3
TOTAL.....	1.8	1.1	5.3	3.3	10.2	5.3	16.8	8.4

The variety of types of farm equipment other than tractors makes detailed analysis impracticable, but recent statistics on exports from major farm machinery exporting countries have been assembled in terms of value in Table 26. These values are at ports in the exporting countries. Some 20 percent should be added for freight and handling charges to obtain landed cost. It should be borne in mind that by 1948 prices of farm machinery had risen by 60 percent over the prewar level in the United States and by a considerably higher percentage in the United Kingdom. In general, the rapid postwar increase in imports appears to be attributable in part to accumulated demand during the war and in part to a more permanent trend towards greater use of modern machinery.

In view of the lack of dollar exchange in several countries of the region and the existence in some of substantial sterling balances, it is of interest to consider the proportions being obtained from dollar and sterling sources as indicated by Table 27. (See also Table 6.) Such items as large crawler tractors are available mainly

Table 27.—MAIN SOURCES OF FARM MACHINERY EXPORTS  
TO NEAR EAST

Country of origin	Value			
	1946	1947	1948	1949
	( . . . . . Million U. S. dollars . . . . . )			
United States.....	3.1	7.7	11.1	27.2
Canada.....	1.0	0.4	2.0	4.3
United Kingdom.....	1.0	1.9	3.4	2.6

from the United States, though recently some heavy equipment has been obtained from Italy and from the United Kingdom, and there are prospects of greater supplies from France.

### *Local Production of Farm Equipment*

It has not been possible to estimate the volume of farm machinery produced in the region, but the industry is evidently of very limited proportions. Hand implements, simple plows, etc., are made by local craftsmen and in small factories in most countries, but



all larger items of modern equipment must be imported. Turkey has a small iron and steel industry and manufactures some horse-drawn and hand equipment. Egypt is planning industrial developments, and there are small centers of industry in other countries; but for the most part, coal, iron, and steel must be imported, and there seems little immediate prospect of producing modern power machinery on a significant scale.

There is, however, considerable scope for improvement in the design and materials of the simpler implements. Even minor increases in efficiency of hand tools and simple plows could considerably reduce the drudgery and increase the output of the small farmer, who is likely to adhere to traditional practices for a considerable time to come. Local industry and agricultural advisory services would perform a most valuable function by close attention to this phase of farm equipment.

With the introduction of power farming on larger holdings, the need for repair and maintenance facilities is growing rapidly. Local manufacture of spare parts is being undertaken in Turkey and Iraq, and additional workshops are being established in these countries and in Egypt, Iran, and elsewhere.

### *Trends and Prospects*

Both governments and landowners in the Near East are displaying considerable interest in the wider use of modern farm equipment. If present plans are carried out, imports are likely to continue for several years at roughly the same annual rate as in 1947 and 1948. Although only a small proportion of total world trade in farm equipment, this would contribute appreciably to the productivity of farm labor on larger farm units, on government projects, and, through co-operative and contract arrangements, on medium-sized holdings. The small peasant holdings characteristic of so much of the region are unlikely to be affected by this movement unless widespread land reform is undertaken. The needs of this class of farmer, as indicated above, lie more in the direction of improved hand and animal-drawn implements.

One important factor underlying the interest in power-farming methods is the rising cost of labor and a comparative scarcity of farm labor in some parts of the region. Another is the ready availability of fuel within the region. This does not apply uniformly to all countries, and fuel problems have been reported from Ethiopia,

Turkey, and Syria, while local distribution facilities are inadequate in some other areas. In general, however, no special difficulty should attend the organization of an abundant supply of cheap tractor fuels and lubricants. This state of affairs contrasts with the lack of good pastures and fodder for draft animals, which are generally of low quality and, with the primitive indigenous implements, cannot deal adequately with many of the soil types of this generally arid, sub-tropical region.

The use of power-operated equipment makes possible in some cases the fuller utilization of soil resources, for example through eradication of weeds. Under some circumstances deep tillage may also have the effect of increasing yields. In Cyprus and other countries of the region, the depth of soil worked has been increased from 7.5 centimeters using traditional equipment to as much as 45 centimeters using crawler tractors. Considerable increases in yield are claimed in some cases. Measures must be taken to maintain soil fertility; otherwise there is a danger of serious erosion in some soils.

Partly related to the question of soils and topography is a local preference for powerful crawler tractors for agricultural purposes. Many observers consider that wheel-type tractors would be suitable for many tasks and would have the advantages over tracklaying types of lower first cost and simplified operation and maintenance. Although the tracklaying tractor is needed on some soils which are slippery when wet and very hard when dry, and in some areas where gradients are steep, the future trend will probably be toward lighter wheel-type units as mechanization extends to smaller holdings and is applied to a greater variety of farming operations. Application of modern farm machinery has been most successful on large holdings on the coastal plains of southern Turkey, in northeastern Syria, in the Nile valley, Israel, and in the upper Euphrates region in Iraq.

Brief details of the plans of some governments of the region indicate the nature and magnitude of mechanization programs. In Turkey, plans have been formalized, in connection with the European Recovery Program, for the introduction of a substantial number of tractors with associated equipment. Some of these would be used on government farms and others on private holdings.

The Government of Iraq has recently approved a 10-year program involving government control over import, distribution, and maintenance of farm equipment. A feature of this program is a government tractor and combine contract service to farmers whose



land and capital resources do not justify owning large equipment. The scheme aims to apply modern equipment to 500,000 hectares of grain land and, through more efficient cultivation and more rapid and timely harvesting and threshing, to raise the annual output of wheat from this area by 100,000 tons. More land will also be brought into use. With existing implements and draft animals, the present labor supply is inadequate to utilize new irrigated land to its full capacity, but the greater efficiency of more highly mechanized operation is expected to relieve the labor shortage by about 25 percent. Under the program, approximately \$10 million is to be devoted to tractors and other farm machinery, 20 percent of which will be spent for spare parts and \$800,000 for workshops. A further \$13 million will be used for soil conservation and drainage equipment. The annual import of tractors would be about 250 units. Ten of the fourteen workshops to be established as part of the government contract service will be mobile workshops. These are to supplement various stationary repair centers in maintaining the 2,500 tractors, 550 combine harvesters, and other items of equipment which it is proposed to employ at quite widely scattered points often remote from service depots. Experience in Iraq has shown the great need for efficient repair services, as a recent report indicates that a substantial proportion of the farm machinery imported in recent years has suffered from breakdowns of one kind or another under the severe conditions of use in the area.

In the Sudan, tractors were applied on a substantial scale to tillage operations and seeding in the production of sorghum during 1945 and 1946. In 1946, 8,000 hectares were sown, but subsequently work has been continued on a semi-experimental scale. Thinning, weeding, and harvesting were done by hand, threshing by stationary machine. Use of row-crop tractors and modifications to seeding and cultivating equipment have been found advisable. By careful selection of strains and mechanical modifications to available machines, combine harvesting would be possible.

The seven-year economic plan authorized in Iran during 1949 proposes extensive modernization of agriculture and irrigation. Increased production of foodstuffs and industrial crops is aimed at, along with improved efficiency of agricultural labor. Wider use of modern farm machinery is one of the measures proposed.

The Israeli Government in 1949 negotiated a loan with the United States Export-Import Bank, making \$35 million available for

the purchase of equipment to accelerate farm mechanization in order to meet the needs of the growing population. It is understood that an additional \$55 million is to be provided from local funds.

Throughout the Near East there is a critical shortage of skilled labor. Where mechanization is being developed, therefore, an essential part of the program is the training of tractor operators and mechanics. The plans in Turkey, for example, provide for the training of 1,000 tractor drivers at seven government-directed stations. The training period is six months; courses are both theoretical and practical, and the trainees are maintained at government expense while attending the schools. In Iraq, also, the program of government control over farm machinery and utilization includes the provision of training courses.

*Lime is rapidly worked into the soil with a tractor-mounted disk harrow.*



## Far East

THE USE of power-operated farm machinery in the Far East is extremely limited; in 1948, with about 23 percent of the world's arable land, the region had less than 0.5 percent of the world's tractors. Furthermore, the slow rate at which this type of machinery is being adopted is shown by the fact that in 1948 the region took only 2.5 percent of the total value of tractors and other farm machinery entering world trade and less than 1 percent of the total world production of these items. There is little evidence to suggest that this rate will be greatly accelerated in the near future. The theoretical potential requirement is, of course, enormous, but fundamental economic and social changes would be necessary for this to be realized.

### *Imports of Modern Farm Equipment*

The estimated number of tractors in use and the recent and prospective rate of import are shown in Table 28. Tractor imports and requirements fall roughly into two groups: (1) heavy crawler-type tractors, with massive equipment for land reclamation and conservation work, (2) medium to light wheel-type tractors with an appropriate range of equipment for tillage, seeding, harvesting, spraying, earth moving, etc., in general farming, orchard work, and minor irrigation projects. Requirements in the first group are mainly in India and Pakistan. In Burma and the Philippines, power farming is being turned to in drier areas; buffaloes and other draft animals are being retained for heavy work in the wet rice areas.

The approximate value of farm equipment exported to the region (including and excluding tractors), as revealed by recent trade statistics of the main farm machinery exporting countries, is shown in Table 29. It should be noted that these are values at ports of origin. In making comparisons, account should be taken of the increased prices of farm machinery.

Many countries of the region have been affected by the general dislocation of world trade and balance of payments in the postwar period. For several years there were severe shortages of tractors

Table 28.—FAR EAST: TRACTOR POSITION<sup>1</sup>

Country	Tractors in use 1948	Tractor imports and stated requirements						
		1937	1946	1947	1948	1949	1950 <sup>2</sup>	1951 <sup>2</sup>
	( . . . . . <i>Units</i> . . . . . )							
Burma.....	<sup>3</sup> 25	—	—	5	33	20	350	500
Ceylon.....	175	—	20	18	35	35	( <sup>4</sup> )	( <sup>4</sup> )
China.....	1,400	30	232	951	7	3	( <sup>5</sup> )	( <sup>5</sup> )
Hong Kong....	1	2	1	7	5	1	—	—
India.....	7,000	101	318	840	2,143	2,424	1,460	2,820
Indochina.....	115	3	—	38	77	110	( <sup>4</sup> )	( <sup>4</sup> )
Indonesia.....	100	39	38	95	72	107	317	310
Japan.....	35	83	—	1	—	2	( <sup>6</sup> )	( <sup>6</sup> )
Malaya and N. Borneo....	125	6	12	64	135	170	( <sup>4</sup> )	( <sup>4</sup> )
Pakistan.....	2,100	—	—	—	86	283	420	570
Philippines....	1,309	138	141	303	306	1,207	591	735
Thailand.....	<sup>3</sup> 25	18	—	6	92	90	20	20
Other.....	. . .	118	—	25	98	. . .	. . .	. . .
TOTAL.....	12,410	538	762	2,353	3,089	4,455	3,158	4,955

<sup>1</sup>Excludes garden tractors.<sup>2</sup>From FAO-ECAFE Joint Working Report, 1948. Stated requirements.<sup>3</sup>Rough estimate.<sup>4</sup>Annual requirements not specified.<sup>5</sup>Considerable stocks were still on hand at the end of 1948, accumulated from UNRRA aid.<sup>6</sup>No estimates available, but quantities likely to be quite small because local industry produces sufficient garden types, and larger units are not needed in large numbers.

and other equipment urgently needed for development projects. Lack of dollar exchange has been a severe handicap. In view of the large sterling balances accumulated by some countries of the region during the war, the great postwar increase in the volume and types of equipment available from the U. K. and Australia has relieved in part the dollar balance-of-payments problems of some members of the region (Table 30). The September 1949 devaluation of sterling has given some competitive advantage to products from the sterling area over those from dollar sources. The granting by the International Bank for Reconstruction and Development of a \$10 million loan to India and the inclusion of certain dependent territories in the European Recovery Program have materially aided in overcoming exchange difficulties obstructing the import of very heavy machinery from the U. S. A. and Canada.



Table 29.—U. S. A., U. K., AND CANADA: VALUE OF FARM MACHINERY EXPORTS TO FAR EASTERN COUNTRIES (INCLUDING AND EXCLUDING TRACTORS)

Country of destination	Farm machinery exports							
	1937		1946		1947		1948	
	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors
	( . . . . . Million U. S. dollars . . . . . )							
Burma.....	—	—	0.5	0.5	0.1	—	0.1	—
Ceylon.....	—	—	0.1	0.1	0.4	0.4	0.3	0.2
China.....	0.1	—	0.8	0.5	2.8	2.0	0.1	0.1
India <sup>1</sup> .....	0.4	0.2	1.6	0.8	4.3	2.4	7.9	3.2
Indochina.....	—	—	—	—	0.2	0.1	0.7	0.4
Indonesia.....	0.2	0.1	0.2	0.1	1.0	0.3	1.1	0.5
Japan.....	0.2	0.1	—	—	—	—	—	—
Malaya and Borneo...	—	—	0.1	—	0.5	0.3	1.0	0.5
Pakistan <sup>1</sup> .....	—	—	—	—	—	—	0.3	0.1
Philippines.....	0.7	0.4	0.6	0.3	3.3	2.9	1.9	1.4
Thailand.....	0.1	—	—	—	—	—	0.2	0.1
Other.....	0.3	0.2	0.1	0.1	0.3	0.2	0.2	—
TOTAL.....	2.0	1.0	4.0	2.4	12.9	8.6	13.8	6.5
GRAND TOTAL <sup>2</sup> .....	2.1	1.1	4.1	2.5	13.7	9.4	14.8	7.5

<sup>1</sup>Separate data for India and Pakistan beginning 1948.

<sup>2</sup>Includes supplies from other exporters for which data are available.

Table 30.—VALUE OF FARM MACHINERY EXPORTS TO THE FAR EAST, BY SOURCE

Country of origin	Value			
	1946	1947	1948	1949
	( . . . . . Million U. S. dollars . . . . . )			
U. S.....	3.0	11.0	10.6	20.8
Canada.....	0.2	0.5	0.5	0.6
U. K.....	0.8	1.4	2.8	3.4
Australia.....	0.3	0.6	...	...
Other.....	...	0.2	...	...
TOTAL.....	4.1	13.7	14.8	24.8



## *Local Production of Farm Equipment*

Factory production of improved farm equipment in the Far East is limited to a few countries and to a restricted range of items. Considerable factory capacity exists in Japan and limited capacity in India, China, and a few other countries. Japanese production in the early part of 1948 was proceeding at a rate approximating an annual output of \$7,000,000 (at the official exchange rate) in some 260 factories. Items produced include garden tractors, power threshers, stationary electrical and internal combustion engines, rice hullers, pumps, plows, etc. An export surplus of some of these items, as well as of food-processing equipment, is reported. Several types of heavy tractors are also produced but are usually not suitable for agriculture. India has factories manufacturing animal-drawn and hand implements and is developing the production of tractor plows; production of tractors is being considered. Some supplies of simple implements may be available for export. In China there are plants capable of producing small motors, hand sprayers, small cotton gins, and a few other relatively simple pieces of equipment. Elsewhere a few factories produce hand tools, e.g., in Indonesia and the Philippines. It is not possible to estimate the present volume of factory production in the region, but it is low and falls short of the imported quantities of modern machinery.

Most of the farm tools needed to supply the hundreds of millions of farmers and farm workers of the region are made by local craftsmen, including carpenters and blacksmiths, and by the farmers themselves. Although practically no statistical information is available to give numerical scale to this highly dispersed industry, allocations to it of iron and steel from imported and locally produced supplies may give some indication of the magnitude of production. For example, the Government of Pakistan stated its needs for ferrous metals for agricultural implements at 50,000 tons annually in a report to the FAO-ECAFE Joint Working Party on Agricultural Requisites; Indonesia requires 1,000 tons of steel a year according to a similar statement, while it is understood that in 1948 the Industry and Supplies Ministry of the Government of India made quarterly allocations of iron and steel to the provinces at a rate equivalent to about 120,000 tons a year for agricultural purposes. These quantities are, comparatively speaking, quite small, but it must be remembered that the purchasing power of the average farmer in this region is so small that implements are very carefully used. Moreover, because of

the acute shortages of wood, metal, and other raw materials, worn-out remnants of hoe heads and plow points are often reworked and other parts repaired or refashioned.

There is little doubt that considerable scope exists for expanded factory production of efficient, relatively standardized implements and machines and for the introduction of improved designs and materials in the products of village industry. A thorough study of the implements, tools, and other appliances in common use and of the reasons underlying their popularity with cultivators may be essential first steps toward raising levels of productivity. It has been claimed that the crude-seeming wooden plows and other locally made implements are based on generations of experience and are often less inefficient than at first they might appear to be, having in mind purchasing power and price, the strength of the workstock and of the farmer, the character of the climate and soil, the manufacturing and repair facilities available, and the farmer's accepted way of life.

A further step might be to consider how existing equipment on farms can be modified in detail to incorporate modern ideas. A case in point might be the addition of a simple seed drill attachment to the wooden plow.<sup>10</sup> A related step would be the introduction of new designs which could be gradually substituted for existing equipment as it wears out. For example, a two-pointed plow might be adopted in place of the single-pointed type; such designs have been developed, which, it is claimed, do twice the work of the single-furrow type, with much less than twice the weight, draft, and cost.<sup>11</sup> Another obvious requirement is properly organized and adequately financed research work for the invention of new equipment, the testing of prototypes, and the selection of both locally made and imported machines most suited for local conditions. Close contact with the farmer, both to ascertain his needs and to acquaint him with new ideas, is a basic prerequisite for any such attempt to improve farm equipment. Government assistance seems essential if properly integrated work is to proceed along these lines and to have concrete results in the form of higher productivity of farm labor.

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<sup>10</sup>D. N. Kherdekar, *Journal of the Institute of Agricultural Sciences*, March 1949.

<sup>11</sup>O. T. Brown, "New Plough for India," *Current Science*, No. 5, May 1949.

## *Trends and Prospects*

It is clear from the information on tractor requirements supplied by governments (see Table 28) that most countries of the region are contemplating only limited extension of power farming in the near future. Despite the large area of crop land and the low existing standard of equipment, no rapid general swing to highly mechanized cultivation is likely. There are several sound reasons for this, the most obvious being the density of rural population in most countries and the lack of alternative avenues of employment. The small size and fragmentation of holdings, the predominance of subsistence farming using family labor, the dependence on livestock for transport, milk, etc. in addition to draft power, and the low purchasing power and conservatism of the farmer are among many well-known contributory factors. There is also the fact that major sections of the region depend on imported fuel supplies and lack mechanically skilled workers and repair facilities. Within this framework, tractors and associated equipment do not fit readily.

Extended use of power-operated equipment is justified, however, in a number of special cases. These include such activities as reclamation of jungle, weed-infested land, and severely eroded lands in India, Pakistan, Indonesia, and elsewhere. There are also other general fields for application in the drier areas of most countries of the region, notably in northern China and northern India and in the uplands of Burma, Thailand, and the Philippines. In Burma and the Philippines there is a special incentive, arising in the case of Burma from the seasonal shortage of farm labor, formerly compensated for by migration from India, and in the case of the Philippines from local shortages of draft animals for wet rice cultivation. Further experimental work along the lines of that conducted in Ceylon, Malaya,<sup>12</sup> and elsewhere is needed to show to what extent tractor-farming methods can profitably be applied to the agriculture of those countries. Fairly favorable results have been obtained in some cases with wheel tractors on both drained and wet rice land, but the majority of the holdings and fields are too small for large equipment. Special interest for the region as a whole centers in such work and in experience in Japan, where considerable progress has been made in introducing electrical and other power-operated

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<sup>12</sup>*Malayan Agricultural Journal*, Vol. XXXI, No. 1, January 1948; Vol. XXXII, No. 3, July 1949.

stationary machines such as threshers, rice hullers, and pumps. It is worthy of special note that agricultural tractors have not been introduced in Japan despite the intensive efforts in that country to improve farming practices. About 11,000 garden-type tractors are reported to be in use, partly for tilling drained paddy fields. Small units of this type, very small crawler tractors, and rotary cultivators may prove to have fairly wide application in the region if fuel, maintenance, and operating difficulties can be overcome.

It is important to remember that heavy mechanization of rice in such countries as Australia and the United States has been successful where large, relatively level areas of suitable soil are available, accurate control of the time and rate of inundating and drainage is possible, and wide strong bunds can be constructed over which heavy machinery can operate. With the equipment at present available, it seems unlikely that rice will be extensively mechanized in the Far East except where these conditions are fulfilled. By intensive study and field trials, however, it may be possible to modify existing designs or develop new machines particularly suited to operating under wet conditions. In many cases where topographical and other technical conditions are favorable, application of power-farming practices may have to await consolidation of small plots and its attendant adjustment of many questions, including land tenure and alternative employment for labor.

### *Mechanization Plans of Governments*

Some aspects of government programs involving mechanization of agriculture are summarized below. Table 28 indicates the approximate numbers of tractors considered necessary for carrying out the initial phases of these programs and for other agricultural needs. Burma, in its Two-year Economic Development Plan of 1948, provided for the establishment of eight mechanized farms of approximately 1,000 hectares each. Ceylon aims at rehabilitation of neglected land and at speedier and more timely planting and harvesting of crops through limited use of tractors. In India the emphasis is on land reclamation and jungle clearing, as will be discussed in further detail below. Indonesia drew up in 1948 a five-year plan for agricultural development calling for some land clearing and limited use of power-operated equipment for crop production. Malaya, in order to increase rice production and make possible more



economic production of other crops, is intensively investigating mechanical methods. In Pakistan, heavy equipment is to be used for soil conservation works on 3.8 million hectares of gullied lands; some lighter tractors with appropriate equipment are also needed for power-spraying and other operations in orchards. In the Philippines, part of the ten-year rice and corn production plan aims at mechanical cultivation of 500,000 hectares of land. Mechanical cultivation in Thailand will be adopted largely for clearing land invaded by tall grasses and cultivating some of the better drained areas.

The long-term land reclamation aspects of India's Food Production Projects have two objectives: (1) the reclamation of part of an estimated 4 million hectares of formerly cultivated land which has fallen into disuse through neglect and lack of physical means to cope with deep-rooted grasses (*kans*) which resist the traditional hand- and bullock-operated equipment, and (2) the clearing of 800,000 hectares of new land, including some jungle areas. The cost of reclaiming the kans-infested land has been estimated by the Indian authorities at roughly \$27 per hectare. Preliminary estimates of \$75 per hectare were made for jungle clearance, but in practice this may be exceeded. In 1949 India negotiated a \$10 million World Bank loan, which will be used in carrying out immediate projects under the general program.<sup>13</sup> Of this amount, \$8.75 million was designated for the purchase in the United States of 345 heavy tractors, ancillary equipment, and spare parts for the eradication of deep-rooted grasses on 400,000 hectares of formerly cultivated land. The remaining \$1.25 million was set aside for 30 heavy tractors with equipment and spare parts for a pilot program of jungle clearance in northern India. This is to assess the practicability and cost in India of large-scale jungle clearing with modern equipment. In both projects, lighter cultivation tractors and equipment are needed for subsequent operations. Much of the reclamation and other work in India will be carried out by the Central Tractor Organization, a government organization equipped with a range of tractors and associated equipment and provided with repair facilities, training schools for drivers and mechanics, and a body of experienced reclamation and agricultural personnel. Additional power-operated equipment is controlled by provincial governments and by private farmers. Special priorities have been granted for reclamation and food production activities in the

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<sup>13</sup>IBRD Press Release No. 144, 29 September 1949.



allocation and transport of tractor fuels. Considerable attention is also being devoted in India to the introduction of improved hand and animal-operated tools and equipment.

The experimental work conducted in Malaya warrants special mention.<sup>14</sup> The investigations have covered a wide field but have concentrated on the possibilities of improving rice cultivation by mechanical methods and of opening up large new rice areas in order to reduce Malaya's dependence on imported supplies. The latter development is considered likely to prove most valuable because the subdivision of existing rice areas into small individual plots makes large-scale mechanization virtually impossible. In general, the available areas in Malaya do not lend themselves to the controlled drainage and inundation which has proved so effective an aid to rice mechanization in the United States and Australia. On the other hand, rainfall is heavy and erratic. Soils, too, vary considerably. On clay soils, wheel tractors with some modifications to the wheel have proved more successful than crawler types; on muck and peat soils neither type was found entirely suitable, but more success was achieved in using the crawler type with substantially modified tracks. The problems that were encountered were associated not only with traction, but also with clogging and sinking of plows, harrows, and other implements. Some of these have been overcome. Interesting conclusions have emerged from these tests; for example, the plowing and harrowing of a representative paddy area with tractors was found to take only one-eighth of the time required when buffaloes and village tools were used. When tractors could be kept operating, costs proved to be moderate; but mechanical breakdown and bogging of equipment reduced the area worked by one-third to one-half, with a consequent increase in the cost of the work performed. This emphasizes the need for efficient maintenance work on both tractors and implements and for skilled, timely operation of machinery, as well as selection of suitable equipment for the prevailing conditions. Garden-type tractors and mechanical cultivators of various types were also tested, with varying results for suitability under paddy conditions. Other trials have been made on the mechanical removal of stumps on rubber and palm plantations and on the eradication of tall grasses (*lalang*) by tillage or by mechanical spraying of weed killers. These methods have proved considerably more economical than the method of removing weeds by hand.

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<sup>14</sup>*Malayan Agricultural Journal*, loc. cit.

In the Philippines there have also been investigations of importance to other areas with comparable conditions.<sup>15</sup> Sugar production has been carried out for many years with the aid of some large machinery, partly of local design, but serious consideration was given to the application of tractors and associated equipment to other crops only after World War II. The loss of 40 percent of the work animals in the country was one of the principal reasons for this interest. Initial attempts at using war-surplus tractors and hastily imported plows, harrows, etc., were discouraging, but intensive work has shown that, with suitable mechanical equipment, upland rice and maize can be produced satisfactorily. The problems associated with lowland rice and beans were approached in 1947, and it was established that crops could be planted earlier and could produce larger yields with power-operated equipment than with traditional methods. Costs and labor requirements were lower. Subsequent measures have aimed at applying these experimental results on a larger scale, particularly in the development of sparsely populated areas. One of the objectives underlying these developments is to raise the standard of living of farm families by increasing the area which they can work with family labor. The carabao can give effective cultivation to about two hectares; by using a tractor, it is hoped to raise the family farm unit to about 24 hectares. Co-operative combine harvesting, drying, and milling of rice produced from units of this size is contemplated.

These examples illustrate the variety of problems common to many parts of the region. There is no doubt that far more extensive research and development work is necessary to ensure not only that equipment shall be appropriate to local requirements, but also that technological changes and the broader economic and social setting shall be kept in harmony.

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<sup>15</sup>*The Philippines Herald*, Rice Supplement, 1 October 1949.

## Africa<sup>16</sup>

THE ONLY PARTS of Africa where power-operated farm machinery is in general use are French North Africa and the Union of South Africa (map, pp. 6-7). The great bulk of the continent is quite sparsely populated and only a small proportion of the land is under cultivation, usually by primitive methods. Physical factors limiting land settlement and use include deficient water supply in the extensive desert and semidesert areas in the northern and southwestern parts of the continent, excessive rainfall and dense vegetation in parts of Equatorial Africa, and the unhealthy nature of many areas because of human and animal pests and unfavorable climate. Soils, too, are often poor.

In addition to these natural factors, the backward methods of the native people limit agricultural output. The plots are normally small and are cultivated with hand hoes. Scientific seed selection, pest control, and use of fertilizers are virtually unknown. Tractors and modern equipment are confined to the larger European-owned farms and estates. The fact that the region has less than 1 percent of the world's tractors on roughly 12 percent of the arable land, and that nine-tenths of these are concentrated in two relatively small areas, illustrates the limited extent to which power-farming methods have been adopted. Introduction of the European-type plow on native holdings has been attempted in some areas but with doubtful success because its use has often been followed by serious soil erosion. Inability of draft animals to survive in large areas of the continent because of disease transmitted by the tsetse fly is a major obstacle to replacement of the hoe system requiring hand labor. Any success which may attend the use of antrycide or other anti-trypanosomiasis measures may have far-reaching effects on the agricultural technology of the region. Almost complete dependence on manual labor places the native agriculture in the central and southern parts of the continent at the lowest level of development. In the northern sections, indigenous implements include the wooden plow and other simple animal-operated implements similar to those of the Near East.

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<sup>16</sup>The Anglo-Egyptian Sudan, Egypt, Eritrea, and Ethiopia are included in the Near East in this report.

## Imports of Farm Equipment

Apart from the output of relatively small factories in the Union of South Africa and in French North Africa, the region is dependent on imports for all of the more complex types of machines. Native craftsmen produce some of the tools used in village agriculture.

Table 31 gives available data on the number of tractors in use in 1948 and on tractor imports in 1937 and in postwar years. It will be seen that 90 percent of the tractors recorded are in French North Africa and in the Union of South Africa; the bulk of exports has

Table 31.—AFRICA: TRACTOR POSITION<sup>1</sup>

Country or area	Tractors in 1948	Tractor exports from United States, United Kingdom, and Canada <sup>2</sup>				
		1937	1946	1947	1948	1949
		( . . . . . <i>Units</i> . . . . . )				
French North Africa:						
Algeria . . . . .	38,200	306	453	739	1,151	1,530
French Morocco . . . . .	5,100	223	275	655	982	860
Tunisia . . . . .	3,000	259	302	380	381	483
Union of South Africa . . . . .	30,000	1,554	3,678	5,031	13,351	10,793
Basutoland . . . . .	5	. . .	. . .	. . .	. . .	—
Bechuanaland . . . . .	13	. . .	. . .	. . .	. . .	2
Belgian Congo . . . . .	4167	6	22	31	99	170
British East Africa . . . . .	2,000	66	282	902	1,618	1,626
Gambia . . . . .	5	. . .	. . .	. . .	. . .	31
Liberia . . . . .	4	. . .	. . .	. . .	. . .	2
Libya:						
Cyrenaica . . . . .	30	. . .	. . .	. . .	. . .	6
Tripolitania . . . . .	126	. . .	. . .	. . .	. . .	
Mauritius . . . . .	5155	. . .	4	21	47	50
Mozambique . . . . .	4174	14	48	96	242	105
Somalia . . . . .	6132	. . .	. . .	. . .	. . .	. . .
Northern Rhodesia . . . . .	400	. . .	4	11	253	117
Southern Rhodesia . . . . .	72,105	. . .	284	363	1,731	1,166
Other <sup>3</sup> . . . . .	. . .	68	120	225	636	1,113
TOTAL . . . . .	51,616	2,496	5,472	8,454	20,491	18,054

NOTE: The Anglo-Egyptian Sudan, Egypt, Eritrea, and Ethiopia are included in the Near East.  
<sup>1</sup>Tractors for all purposes, excluding garden tractors. Figures are based in most cases on official information.

<sup>2</sup>Canadian tractor exports are very limited.

<sup>3</sup>4,600 used in agriculture.

<sup>4</sup>1947.

<sup>5</sup>12 used in agriculture.

<sup>6</sup>29 used in agriculture.

<sup>7</sup>1,976 used in agriculture.

<sup>8</sup>Includes exports to specified countries for which data are not shown, as well as to countries not listed.

also been directed to those areas. In the rest of the continent, Rhodesia and some of the territories in British East Africa have made most progress in the use of tractors, principally on plantations and European farms. The increase in imports since the war has been particularly striking. The exceptionally large figure of over 13,000 units for the Union of South Africa in 1948 is largely accounted for by the shortage of supplies during and following the war. Since 1948, restrictions have been applied to dollar purchases and the accumulated demand has been largely satisfied; imports have therefore been reduced. As is true of other parts of the region, however, the steady demand for tractors and associated equipment seems likely to be much higher than before the war.

The value of farm machinery, including tractors, entering the region in 1948 was sixfold that in 1937 (see Table 32). As price increases in the main exporting countries ranged between 60 and

Table 32.—VALUE OF FARM MACHINERY EXPORTS TO AFRICA

Source and destination	1937		1946		1947		1948	
	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors	Total	Excl. tractors
( . . . . . Million U. S. dollars . . . . . )								
From Canada, United Kingdom, and United States to—								
French North Africa:								
Algeria . . . . .	0.9	0.3	2.3	1.4	4.3	2.6	3.6	1.7
French Morocco . .	0.7	0.3	1.3	0.8	4.4	2.7	4.0	2.1
Tunisia . . . . .	0.9	0.4	1.3	0.8	2.6	1.8	2.1	1.3
British East Africa Union of South Africa . . . . .	0.5	0.3	1.2	0.7	4.3	3.6	7.8	5.7
Africa . . . . .	6.6	4.7	10.7	6.2	18.7	11.1	38.2	18.5
Other . . . . .	0.7	0.3	2.3	1.2	5.0	1.2	10.9	3.5
TOTAL . . . . .	10.3	6.3	19.1	11.1	39.3	23.0	66.6	32.8
From other exporting countries to the region <sup>2</sup> . . . . .	2.6	2.6	2.3	1.7	5.9	5.6	13.2	9.8
TOTAL . . . . .	12.9	8.9	21.4	12.8	45.2	28.6	79.8	42.6

<sup>1</sup>Converted at official rates of exchange.

<sup>2</sup>Mainly from France to French North Africa; also includes supplies from Australia, Germany, Sweden, and Switzerland.



Table 33.—PRINCIPAL SOURCES OF FARM MACHINERY  
EXPORTS TO AFRICA

Exporting countries	1937	1946	1947	1948	1949
	( . . . . . Million U. S. dollars <sup>1</sup> . . . . . )				
Canada.....	1.5	2.5	4.1	6.1	4.1
United States.....	7.9	13.8	30.5	46.1	50.4
United Kingdom.....	0.9	2.8	4.7	14.4	15.5
Australia.....	0.2	0.5	0.8	1.0	. . .
France <sup>2</sup> .....	0.1	1.1	4.1	10.2	12.9
Other <sup>2</sup> .....	1.4	0.7	1.0	2.0	. . .
TOTAL.....	12.9	21.4	45.2	79.8	82.9

<sup>1</sup>Converted at official exchange rates.

<sup>2</sup>Approximate figures.

100 percent in terms of dollars, it is clear that the volume of imports had more than trebled. The higher proportion accounted for by tractors in the postwar years illustrates the trend toward power-farming methods. Table 33 shows the main sources of tractors and other farm machinery exported to the region. Before the war about 75 percent of supplies were obtained from dollar sources; the largest non-dollar supplier was Germany. Immediately after the war an even higher proportion was received from North America; but by 1948 both the United Kingdom and France had become important exporters to the region and, notwithstanding heavy imports of tractors from the United States, the share contributed by dollar countries had declined to 65 percent of the total. Since 1948, imposition of stricter exchange controls—particularly in the Union of South Africa, which is the largest importer in Africa—and greater production in Europe suggest that there is likely to be less dependence on dollar sources of supply.

### *Problems To Be Overcome*

For most of the region there is insufficient experience on which to base conclusions regarding the desirability or economic feasibility of introducing more advanced agricultural equipment. A number of governments are investigating these matters, but so far few reliable comparisons have been made, for example, between the

relative costs of "native" and power-farming practices in crop production in Africa. Immediate extension of tractor-farming can most readily be expected in the areas already experienced in these methods and on large holdings and projects under European management. The likelihood of introducing tractors into village agriculture is much more remote. There are, however, some sets of circumstances under which modern equipment may be a valuable supplement to traditional practices, while there is undoubtedly scope for improvement in hand tools and the introduction of animal-drawn implements in some places.

Considerable areas with a well-defined rainy season and accessibility to market outlets may lend themselves to the use of tractors for tillage during the all-important few weeks following the rains. Hoe cultivation is too slow to permit large areas to be tilled while the soil is in a suitable condition for crop germination and growth. Some of the subsequent operations of weeding, harvesting, and threshing may be performed more economically by hand methods in many of these areas, the tractors being employed mainly for plowing and for weed destruction or nonagricultural purposes in the dry season. It is of interest in this connection that in the extensive grain-sorghum scheme in the Anglo-Egyptian Sudan in 1946 and 1947, tractor equipment was used for plowing and seeding only; weeding and harvesting were done by hand and threshing by stationary threshing machines.<sup>17</sup> If a suitable compromise of this kind can be worked out, introduction of machinery may not result in unemployment; on the contrary, the larger areas that can be tilled will create greater opportunities for work. Where, however, the demand for hired labor for growing high value crops is heavy, as in parts of Uganda, some displacement of workers would probably occur if labor-saving equipment were introduced on a large scale. In tropical rain forest areas there is much less justification for the introduction of mechanical methods because there is usually no clearly marked growing season, the types of crops grown are less adaptable to existing types of machinery, and the labor supply is adequate in most populated areas.

Important directions in which heavy equipment can be of special value are in land clearing, in plowing of heavy land, in levelling and bund construction for irrigated farming, and in other constructional work, e.g., for soil conservation. The British groundnuts

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<sup>17</sup>See section on the Near East, p. 65.

scheme in Tanganyika has shown that dense vegetation can be effectively cleared with appropriate equipment, though in the initial stages of this project progress was unexpectedly slow, and costs—originally estimated at \$75 per hectare—were from four to ten times the original estimates. Valuable lessons have, however, been learned and may be applied in future work.

As indicated above, tractors are being used to supplement and, in some cases, replace hand labor, but there are also possibilities in some areas of employing work animals on a more extensive scale. The high price of tractors and power-operated equipment and the need for adequate fuel supply, repair facilities, trained mechanics and drivers, and skilled supervisors, as well as the necessity in many places of replanning farms and improving transport facilities for mechanical cultivation, would mean that the over-all costs of introducing tractors would make farm production costs much higher than they are with existing hand methods. Animals, on the other hand, could live off the land in many areas and would involve comparatively little increase in production costs, but would give valuable assistance to manual labor for heavy operations. Control of livestock diseases and a change in the reverent attitude of many of the Bantu tribes toward cattle and horses are slowly being brought about. The fact that many of these peoples are familiar with handling livestock may prove to be another favorable factor.

There is no doubt that any movement for a higher degree of mechanization of agriculture in the underdeveloped parts of Africa, whether on the basis of mechanical or animal power, must take special steps to solve attendant problems of correct operation and maintenance of equipment, training of personnel, and the more complex management and financing involved in more highly developed production techniques. In projects managed by governmental or semigovernmental agencies or by large private groups, these questions receive organized attention, as in the British Overseas Food Corporation's activities in East Africa and the co-operative services in French North Africa. This is also true in the various experimental projects in other territories. It is significant that the British Overseas Food Corporation in East Africa has found it necessary in the light of experience to strengthen its Inspectorate, which is responsible for checking the standard of machinery maintenance. This has resulted in the early detection of many incipient faults which an experienced and conscientious operator would on his own

initiative have noticed and reported before they became serious. The reduction in negligence which has been achieved has more than paid for the expense of the inspection service in reduced fuel consumption, saving in time and labor, and the ability to do more work with fewer repairs and replacements of machinery.

Where machinery passes into private hands, responsibility for correct operation and maintenance rests on the individual cultivator and the manufacturer or his agent. Mobile workshops to ensure prompt repair work even on distant farms and special training schools for native tractor drivers have been found desirable by progressive agents in Rhodesia to ensure prompt repair of machines and their intelligent operation. In extending machinery services to native cultivators, experience has shown the value of charging for such services by a share of the crop, rather than in cash; this practice has been successful in the co-operatives of the Tunisian Welfare Society. Management of credit and savings has also been found desirable in some cases where the farmers are not familiar with financial transactions, e.g., in Northern Nigeria.

Turning to actual programs for improving agricultural practices in Africa, it is found that no rapid general changes are contemplated in the near future. The principal colonial powers—the United Kingdom, France, Belgium, and Portugal—have undertaken plans in the postwar period for general economic development of the region over approximately ten years. These include some provision for mechanizing agriculture, but the emphasis in the majority of cases is on experimental work, demonstration farms, or specific projects under direct European management, such as the French and British groundnuts schemes. In the British colonial territories, apart from special projects of this type, mechanization is being encouraged only where it fits in well with the land tenure system. Close attention is being paid to survey and development work. In some areas modern machinery is being actively applied to native agriculture. In Tanganyika, for example, tractor-drawn plows are being used on soils which are too hard in the dry season and too heavy after the rains for manual labor; and in the Rufiji River rice-growing project, large areas are being tilled mechanically on a contract basis for the holders of individual plots of about half a hectare. In French Equatorial Africa it is proposed to plant 120,000 hectares for oilseed production; elsewhere minor projects predominate, e.g., one mechanized area in Guinea, several stations in the

Cameroons, and three model farms in Togoland. In French West Africa an extensive groundnuts project is contemplated as well as a long-term development of rice production. In French North Africa, where agriculture is more highly developed, there are vigorous improvement programs both for European and Moslem farmers. In Tunisia the machinery co-operative movement started before the war is being encouraged. Rural co-operatives in Algeria have also expanded rapidly since 1945, and by 1948 were operating with heavy equipment on about one-tenth of the cereal area. As land holdings in Morocco average about 10 hectares in area, progress of heavy mechanization is being developed on a collective basis, both for breaking new ground and for cultivation of existing farms. These territories are included in the European Recovery Program; deliveries from dollar sources are therefore available to supplement the limited supplies that French industry has been able to provide. It is estimated that 15,000 to 20,000 tractors may be imported between 1949 and 1955.

In the Belgian Congo there has been some application of modern equipment on larger estates and European farms; the authorities consider it unlikely, however, that use of machinery in native agriculture will pass beyond the experimental stage in the next ten years. Portugal has announced a development plan for Angola and Mozambique, but it applies to transport and industrialization and does not extend to farm mechanization.

In the Union of South Africa most European farmers employ advanced methods and equipment; for example, in 1946 one tractor to every 320 hectares of farm land owned by Europeans was reported, and the ratio has increased considerably since then. Both sales and use of farm machinery are almost entirely in private hands, and no major government projects are necessary apart from regular technical advice given through government departments. Manufacturers are actively engaged in research on local requirements with a view to expanded manufacture.



# Oceania

GREAT LAND RESOURCES in relation to population, combined with highly developed agricultural technology, make possible extremely high standards of living in Australia and New Zealand, although secondary industry plays a much smaller part in the national economy than in most other countries with comparable living standards. This is in large measure due to the fact that agriculture concentrates on high-priced protective foods such as meat and dairy products for specialized markets, and on items such as wool and wheat, which depend on extensive methods with a low labor requirement. The use of advanced techniques under these unusually favorable natural and economic conditions has resulted in remarkably high levels of labor productivity in agriculture. It is of special interest, therefore, that the ratio of tractors to arable land is not exceptionally high; for with 1.5 percent of the world's arable land the region had in 1948/49 1.9 percent of the world's tractors, i.e., about the same ratio as in Europe.

Apart from these two countries, the region includes a large number of small islands.<sup>18</sup> Most of these are relatively underdeveloped, producing copra and sugar for export and other crops for local consumption. In the aggregate, they form only a small fraction of the region.

## *Production and International Trade in Farm Machinery*

Both Australia and New Zealand have an efficient local industry that produces a substantial share of their farm machinery needs (Table 34). In Australia the industry specializes in large tillage, seeding, and harvesting equipment for the production of wheat and other small grains. Some of this machinery is of original design suited to local conditions. Quite large quantities are exported to South Africa, New Zealand, India, and other markets, although control over exports has been imposed in postwar years to ensure that domestic farmers are not deprived of needed supplies. In New Zealand the industry is smaller and produces a more restricted range. Milking and dairy equipment is manufactured in both countries, but in insufficient quantity to meet the needs of local dairy farmers.

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<sup>18</sup>The Hawaiian Islands are included with North America.

Table 34.—AUSTRALIA AND NEW ZEALAND: VALUE OF FARM MACHINERY PRODUCTION, EXPORTS, AND IMPORTS

Item	Australia			New Zealand	
	1938/39	1946/47	1947/48	1938/39	1947
	( . . . . . Thousand U. S. dollars <sup>1</sup> . . . . . )				
Production:					
Tillage implements. . . . .	1,720	3,770	. . .	2,920	. . .
Seeding " . . . . .	860	1,135	. . .		
Harvesting " . . . . .	1,770	4,060	. . .		
Dairy equipment. . . . .	1,030	520	. . .	405	. . .
Tractors. . . . .	—	. . .	24,000	—	. . .
TOTAL <sup>3</sup> . . . . .	13,280	21,680	. . .	4,370	. . .
Exports:					
Tillage implements. . . . .	82	1,865	1,683	. . .	. . .
Harvesting " . . . . .	27	594	302	. . .	. . .
Dairy equipment. . . . .	12	137	191	133	. . .
TOTAL <sup>3</sup> . . . . .	340	3,640	3,138	. . .	. . .
Imports:					
Tillage implements. . . . .	233	219	316	1,370	2,110
Seeding " . . . . .	19	18	11		
Harvesting " . . . . .	276	928	2,430		
Dairy equipment. . . . .	785	933	1,583	447	710
Tractors and parts. . . . .	4,250	11,737	13,691	3,140	4,180
TOTAL <sup>3 4</sup> . . . . .	5,280	13,939	18,117	4,940	7,040

<sup>1</sup>Converted at official rates of exchange.

<sup>2</sup>Estimate for 1948/49.

<sup>3</sup>Includes other farm machinery not specified.

<sup>4</sup>These figures are not strictly comparable with those used in Table 3 and in dealing with other regions because this table is based on official Australian and New Zealand statistics and not on export statistics from Canada, the United Kingdom, and the United States.

Tractor production has begun in Australia, and by 1948 had reached 2,000 units a year. Double this output was planned for 1949.

Tractors and parts account for a large proportion of farm machinery imported into the region (Table 34). Prior to the war these imports were obtained principally from the United States, but the acute dollar-exchange problems of the postwar years have resulted in stringent regulations to ensure that, as far as possible, supplies will be obtained from non-dollar sources. These policies, coupled with increasing availability of tractors and other equipment from the United Kingdom, have effected a major shift to sterling sources, as shown in Table 35. During the war years and in 1946 and 1947 extreme difficulty was experienced in obtaining adequate quanti-

Table 35.—AUSTRALIA AND NEW ZEALAND: SOURCES OF FARM MACHINERY IMPORTS, BY VALUE<sup>1</sup>

Source	1937	1946	1947	1948	1949
	( . . . . . Percentage of total value . . . . . )				
United States.....	81	66	80	45	45
Canada.....	4	2	2	1	1
United Kingdom.....	10	26	16	52	54
Australia <sup>2</sup> .....	1	3	2	2	. . .
Other.....	4	3	. . .	. . .	. . .
	( . . . . . Million U. S. dollars . . . . . )				
TOTAL VALUE .....	15.5	9.6	21.7	32.4	54.4

<sup>1</sup>Based on export statistics of main supplying countries, priced at ports of origin.

<sup>2</sup>Imported by New Zealand.

ties, particularly of tractors, from abroad. By 1948 supplies were becoming more abundant, but even in 1949 full requirements of such items as heavy tractors could not be met.

### *Direction of Future Progress in Mechanized Farming*

The area of cultivated land in the region is a comparatively small portion of the total area (map, pp. 6-7). In Australia, production of wheat, oats, and barley accounts for the bulk of the cultivated area. Other important crops include vegetables, maize, fruit, and sugar. New Zealand has an extremely limited area under crops, but much of the land is in improved pastures. The average size of farms in the region is quite large, calling for fairly big equipment. The preference in Australia is for tractors of over 25 horsepower, though increased mechanization of horticulture in recent years has created a demand for smaller types. Conditions in New Zealand call mainly for medium and light equipment.

In both countries there has been a progressive decline in horse numbers on farms, counterbalanced by an increase in tractor numbers and motor trucks. By 1948, Australia reported 80,000 tractors and New Zealand 21,000. A considerable number of Australian grain farmers in districts where grazing land is abundant have retained horses for draft power, while employing large modern tillage equipment, seed drills, and harvesters. Big holdings ensure long

hours of utilization where tractors are used. These two factors largely account for the comparatively low ratio of tractors to the area of cultivated land noted above. In New Zealand also, although one tractor was reported for each 25 hectares of cultivated land in 1948, in practice the number of tractors used for actual crop production is not exceptionally high in relation to area under crops. The abnormally high apparent ratio is explained by the fact that many tractors are used for scarifying and top-dressing semipermanent pastures, which are plowed and seeded at intervals of about five years but cannot be regarded as cultivated land in the usual sense and are not included in the cultivated area. Semipermanent pastures of this type are also growing in popularity in Australia.

An annual requirement of 10,000 tractors to replace normal wastage and allow for the spread of power-farming practices has been estimated by the Commonwealth Government for Australian agriculture. Roughly 2,500 units may be needed annually in New Zealand. Imports in some recent years have exceeded these figures, but this has been to compensate for the shortages which resulted from interruption of normal supplies during and after the war. Local production is unlikely to supply more than a third of these needs for some time to come although, as seen above, the bulk of requirements for farm equipment other than tractors is supplied by the domestic industry. Adoption of modern equipment has made some progress in the numerous islands included in the region, as shown by the fact that 16 tractors were reported from the British Solomon Islands in 1948. Scope for more modern practices exists in the quite substantial sugar plantations in the Fiji Islands and in various other enterprises distributed over this extensive region.

*A fleet of self-propelled combines harvest and thresh wheat on the North American plains. This represents an extreme case of high capital input balanced by low labor requirement.*











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